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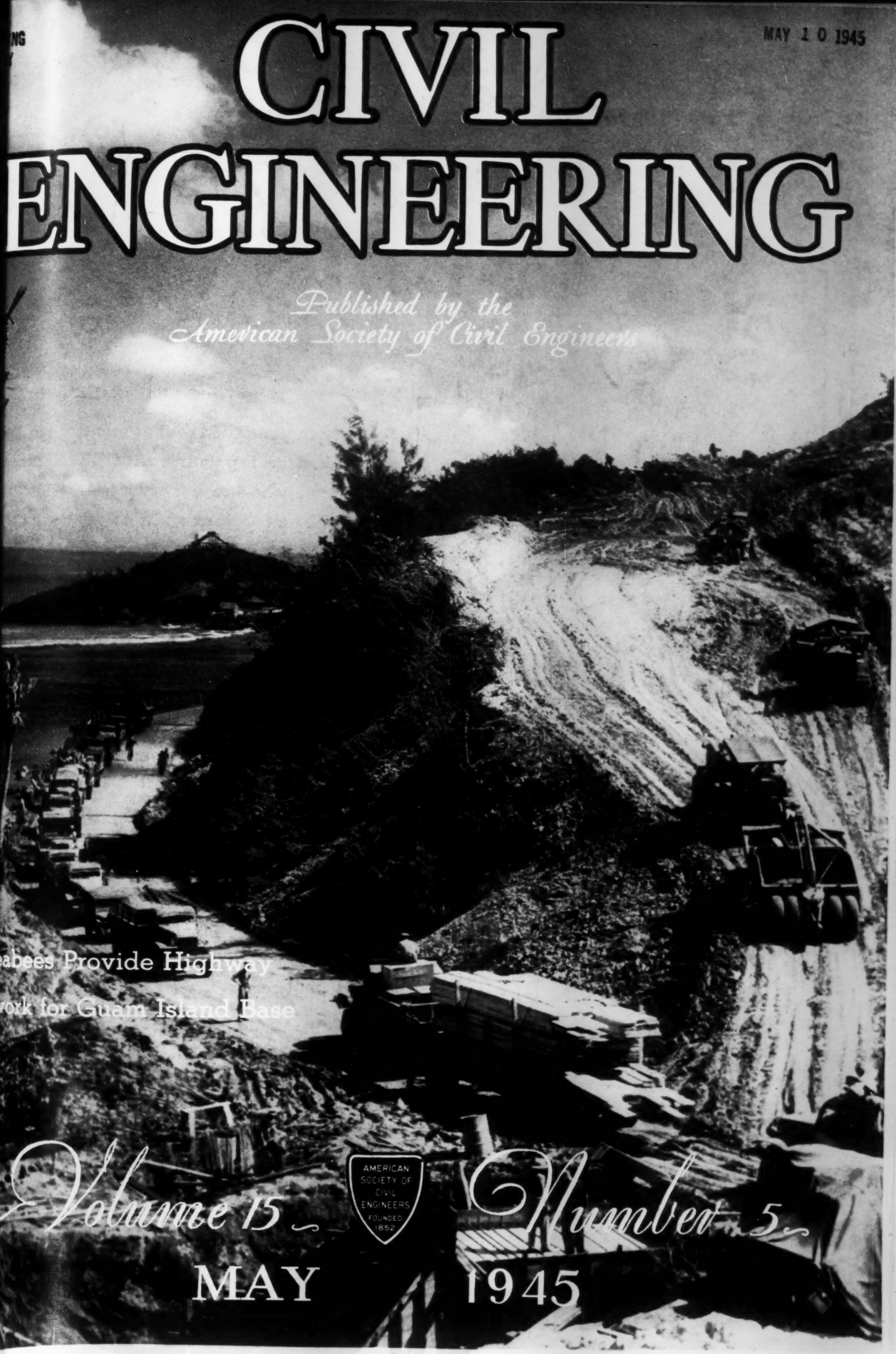

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Volume 15 Number 5
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Volume 15 May 1945 Number 5

Bailey Bridge Units Mass Produced

Use of Jigs in All Operations Assures Accuracy of Fabrication

By C. W. Ogden, M. Am. Soc. C.E.
Chief Engineer, Virginia Bridge Company, Roanoke, Va.

THE Bailey Bridge, named for its British designer, Donald Coleman Bailey, has caught the imagination of civilians and members of the armed forces alike. Variously described as a "panel bridge," a "gigantic jig-saw puzzle" and the "Royal Engineers' Dream," it has also been aptly compared, in the people's mind, to the well-known child's erector set. Experience has shown it to be the most adaptable and efficient design yet devised for a portable military highway bridge.

Made mostly of high tensile steel, it combines lightness and simplicity of field assembly with its adaptability to various span lengths and loads. The Bailey Bridge has been used for single spans between supports up to 180 ft. Spans up to 240 ft may be realized. Much wider crossings are possible when bridge spans are supported on intermediate bents and piers or floated on pontoons. All parts are interchangeable and field connections are made with a minimum number of pins and bolts. Only two sizes of pins, three sizes of bolts, and one type of clamp are used for erecting an entire bridge, including the flooring for the roadway and footwalk.

Designed for erection by manpower alone, under difficult erection conditions, without the use of mechanical equipment, its various units are shop assembled to keep the number of shipping pieces to a minimum. The heaviest piece, a panel, weighing only 594 lb, can easily be handled by six men.

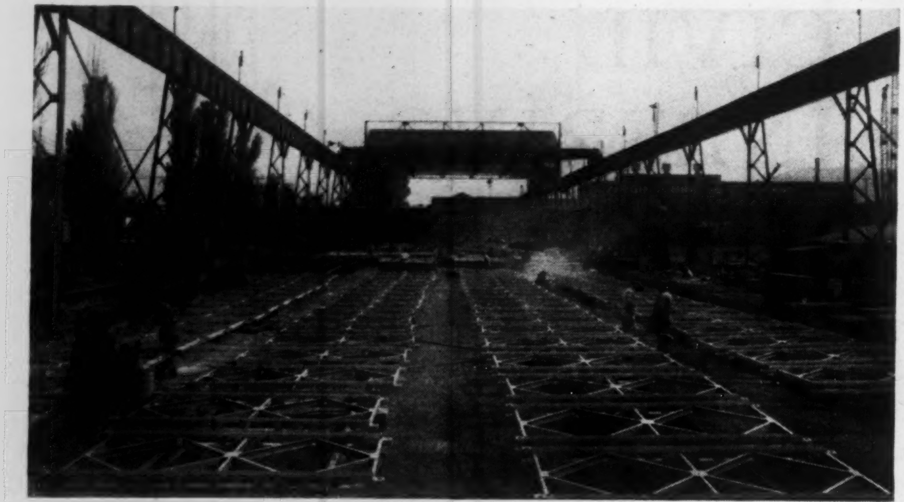
Over two years ago, contracts were let in this country by the U.S. War Department for the secret production of these bridges for use by our Army, and to supplement those being fabricated in Great Britain. Each contractor was assigned a certain number of basic bridges. A basic bridge consists in general of the requisite number of shop-welded panels and other parts to make a single span 150 ft long for one-way traffic, with a 20-ft ramp at each end and a footwalk on each side for pedestrians. In addition, a certain number of spare parts were ordered for each basic bridge. Some of these were to be included with the basic bridge when it was shipped overseas, and others were to be assembled at a supply depot to replace those units damaged or lost in the field of operations.

The design is unique in that span lengths can be varied by 10 ft, by connecting together the desired number of panels, which are 10 ft 0 in. long and 4 ft 9 in. deep, center to center of pin holes, to form the trusses. The ramps at each end of the structure can also be varied in 10-ft lengths.

CAPACITY EASILY INCREASED TO MEET NEEDS ENCOUNTERED IN THE FIELD

The carrying capacity of a span can be increased by using one, two, or three trusses in a single tier, or two and three trusses in two or three tiers on each side of the roadway. Each tier of trusses is connected by special bolts to make them act as a unit, and the trusses are braced to each other by shop-assembled bracing frames. Depending upon the number of trusses to be used, the several types are designated as a single-single, double-single, triple-single, double-double, triple-double, and triple-triple.

Closely Following the Retreating Enemy, Army Engineers Assemble Bailey Bridge Units for a Pontoon Crossing



ASSEMBLED UNITS ARE CLEANED AND PAINTED IN THE YARD

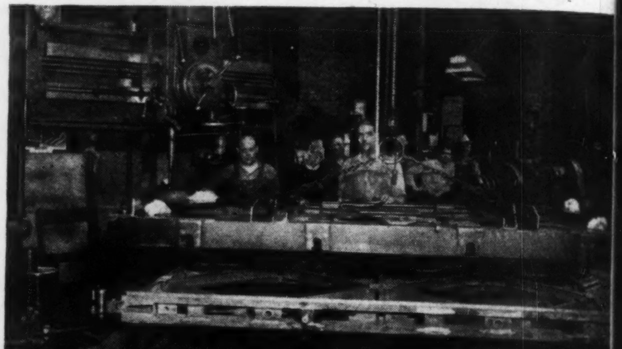
Floor beams or transoms connect to the trusses at 5-ft intervals, and at their ends support cantilevered footwalk bearers or brackets which, in turn, support the 2-ft 6-in. wide shop-assembled wooden footwalk sections. Pipe handrail posts connect to the ends of the footwalk bearers and support a rope handrail. Steel stringers for the main span and ramps are shop assembled into units 10 ft long, of 3 I-beams each, and rest on the floor beams. The roadway flooring, known as chess, is wooden plank 2 in. thick, formed at the ends to fit between steel buttons welded to the tops of the outside lines of stringers, and these buttons space the plank with an opening of approximately $^1/_2$ in. These planks are held down by wood or steel guardrails (ribands), which are clamped in position to the outside lines of stringers by means of "J" bolts.

UNUSUAL SPECIFICATIONS

The specifications covering the fabrication, cleaning, painting, and shipping of these bridges are unusual for a structural shop. In general, the tolerances specified for length of pieces are plus or minus $^1/_{16}$ in. However, for the truss sections the overall depth must be held to plus or minus $^1/_{32}$ in., the vertical distance center to center of pin holes to plus or minus 0.025 in., and the difference between the diagonal distances center to center of pin holes to $^3/_{64}$ in. The truss pin holes are drilled to a tolerance of 0.005 in., and the pins turned $^1/_{32}$ in. smaller, to a tolerance of plus 0.000 and minus 0.005 in. These close tolerances are required by the necessity for complete interchangeability with parts fabricated by other shops in the United States and Great Britain, and to keep the deflection or sag of the trusses to a minimum.

RIGID INSPECTION IN THE SHOP

Each completely fabricated panel, before being accepted, must pass a very rigid inspection. The Army inspectors use special gages for checking the distances between pin holes in addition to the usual examination for workmanship, alinement, and fit of the several pieces in the assembly. These gages, made of steel, have pilot pins at each end which fit into the pin holes of the truss panel. A separate gage is used for checking the location of the chord-connector bolt holes, the bracing-frame bolt holes, and the horizontal distance between pin holes. Another gage is used for checking the vertical distance between pin holes and the overall depth of the panel section; a third gage for checking the diagonal distance between pin holes; and a fourth gage for checking the location of the holes for connecting the bracing frames to the panel end verticals. While the tolerances noted previously must be adhered to in any one line of holes, the distances between holes in any two similar lines—either horizontal or vertical—must not vary from each other more than $^1/_{32}$ in.



A JIG LOCATES MAIN PANEL HOLES ACCURATELY FOR DRILLING

A PILOT MODEL WAS ASSEMBLED AND A TEST LOAD APPLIED

ACCURACY OF GAGES MAINTAINED

The gages are constructed so that they can be locked to indicate the exact measurement between two pin holes and to show the variation in length between these holes and any two other holes similarly spaced. Similar gages are used for checking the truss bracing frames. The accuracy of these gages is maintained by a periodic check against master gages. All other pieces and assembled units are carefully gaged and checked in a manner comparable to the best modern machine-shop practice.

One basic bridge contains approxi- ately 72 tons of steel. It is made up about 31,000 detail pieces and is com- etely shop welded, requiring $3^1/_3$ les of weld in its fabrication.

In order to provide for quantity oduction of these bridges economi- lly, and .to insure the proper fit and inement to the close tolerances speci- d, it was necessary to construct a mber of very expensive jigs for as- mbling, welding, and drilling the rious pieces. Some of these are sitioning jigs used to avoid the neces- y for overhead welding. Others are uch more elaborate, and are designed t only to position the various detail eces but also to hold shrinkage and stortion of the welded parts to a inimum. It is necessary to inspect ese jigs constantly while they are ing used to see that all parts are pt in their correct position and to place parts that have become worn. pare jigs are kept in reserve to re- ace those that need reworking in der not to delay production.

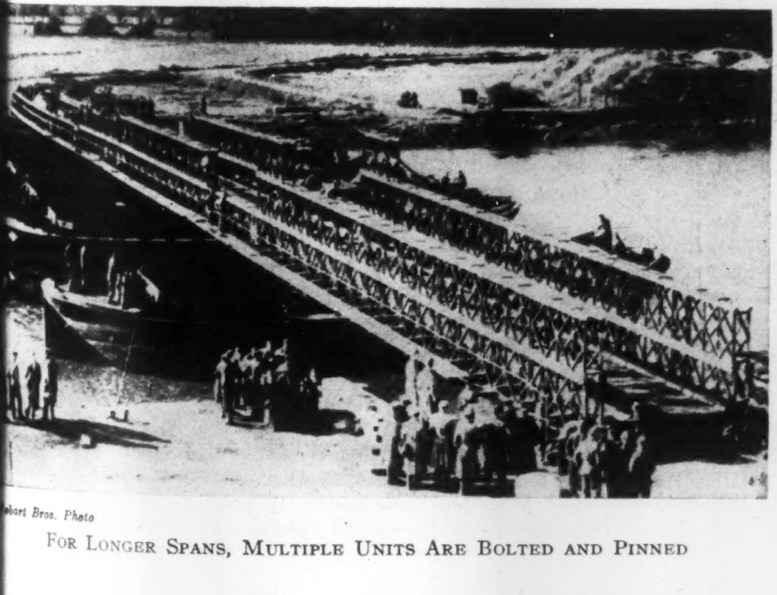
ON THE PRODUCTION LINE, ASSEMBLY JIGS ASSURE EXACT DIMENSIONS OF FABRICATED BRIDGE UNITS

After fabrication, the steel is cleaned all rust, scale, and weld spatter. All burrs, rough edges, d edges of punched and drilled holes are filed or ground ooth. Special care is exercised in this latter operation as to minimize the possibility of injury to the men ndling the material in the field.

MASS-PRODUCTION WELDING IS DONE IN BOOTHS WITH THE AID OF POSITIONING JIGS

PAINTING AND PACKAGING FOR SHIPMENT

After cleaning, the steel is given one coat of primer d one finish coat of gray lusterless enamel paint. Air rays are used for applying all paint. Bolts, nuts, pins, d threaded parts are cleaned and given one coat of avy rust-preventive compound. One coat of rust- eventive oil is applied to the ratchet wrenches used r erection. These processed pieces are placed in oden boxes made of $^3/_4$-in. sized oak lumber and lined ith heavy creped waterproof paper. All boxes are nded with a minimum of two continuous steel bands curely stapled to the box. The other steel members e assembled into bundles, which are held together ith bars, bolts, or steel straps, using oak blocking and otection pieces where necessary.



bart Bros. Photo

FOR LONGER SPANS, MULTIPLE UNITS ARE BOLTED AND PINNED

One basic bridge requires 6,825 fbm of lumber for the flooring of the roadway and footwalks. This lumber, shipped from the Pacific Coast, is select structural-grade Douglas fir dressed on four sides, and is treated by dipping in a solution of wood preservative. After drying and assembly, it is given one coat of primer and one coat of gray paint of the same specification as used on the steel. When the paint is thoroughly dry, the floor plank and footwalk sections are made into bundles, securely strapped in preparation for shipment.

All boxes and bundles are stenciled to show the purchase order, requisition number, description of contents, cubage, and gross weight. Each bridge is shipped in 58 bundles containing a total of 870 pieces, and 29 boxes containing 1,900 smaller items. The boxes and bundles vary in weight from 74 to 4,575 lb each. Three large-size gondola cars are required to ship one bridge. The total shipping weight for one basic bridge is 162,437 lb.

A More Logical Highway Bridge Loading

Determination of Proper Live- and Dead-Load Safety Factors Calls for Study of Basic Principles Underlying Present Design Specifications

By STEWART MITCHELL, M. AM. SOC. C.E.

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PRESENT practice in the design of highway bridges uses loadings that provide little or nothing as a safety factor for future increases in weight or concentration of axle loads. A safety factor is obtained, however, by limiting the stresses produced by the loadings to a value well below that which will cause serious damage. As the result of this practice, existing highway bridges differ materially in their load-carrying capacity; their real capacity varies principally with span length and kind of material. There is need, Mr. Mitchell points out, for a study of the basic principles that underlie present design specifications, particularly with regard to proper live- and dead-load safety factors.

SOME years ago, a professor of descriptive geometry in a Midwestern university had a stock introduction for his demonstrations which was delivered with a rich brogue: "Assume a 'pint' and wur-rk accurately from it." The remark was apropos in its application to his subject, but it looks as though many structural engineers may have adopted it as a general working principle. Technical literature now is full of "new" methods to promote accuracy in computing stresses in rigid frames, columns and what not, and not very much about correct values for the forces which produce these stresses. Recently, bridge engineers have made an effort to find out whether the standard design loading which they have been using for twenty years has a logical relation to actual highway vehicle loads. This is a step in the right direction and, if followed up, will bring about more logically designed structures than those built during the past twenty years.

It will be admitted that nobody can foretell very far ahead what the highway vehicle loads will be. Nevertheless, engineers cannot escape the fact that they must design every bridge for a definite maximum loading, as precisely as their knowledge of forces and materials will warrant. Certainly, they must admit that there is little logic in deliberately designing one bridge, or one span of a bridge, to have a much greater load-carrying capacity than another one next to it. Experience gained by having to determine what existing bridges can safely carry in the way of actual vehicle loads has proved that there is a great difference in their real load capacity.

The ability to withstand heavy loads is mainly a function of the length of the span and the material of which the bridge is constructed. It will be observed that these factors have a preponderant influence on the relative amount of live- and dead-load stress in structural members; hence the proportion of dead- to live-load stress is a primary factor in determining the real load-carrying capacity.

A bridge designed by the standard methods used for many years is shown in the accompanying photograph. An analysis of the structure shows that the longer span has twice the "overload" capacity of the shorter one, based on the rating specifications of the American Association of State Highway Officials. If the present design stress value of 18,000 lb per sq in. had been used, the difference would be relatively less because it is closer to the assumed maximum "safe" stress. On the other hand, if the shorter span, instead of having two girders, had been designed with four, as is the case with other bridges on the same road, the difference would be increased somewhat because of the lighter dead load.

Before discussing the amount and use of highway bridge loadings, it will be helpful to review the major factors that enter into the design of a bridge. They are:

1. The design loading, which must approximate the effect of any possible weight and grouping of axles that will come on the bridge.
2. The maximum stresses which the material can endure without damage. This involves:
   - *a*) Quality of manufacture and fabrication
   - *b*) Variation in strength of individual pieces of the same kind and grade of material
   - *c*) Frequency of occurrence of critical stresses or of reversals
   - *d*) Possibility and degree of long-continued loading
3. The assumptions made in order to reduce the laws of theoretical mechanics and properties of materials to practicable rules for calculating stresses in all parts of a structure.
4. The limitations on stiffness, deflection, vibration, and similar factors.

AN ILLUSTRATION FROM BEAM DESIGN

In order to illustrate the relation between the loading and safe stress value, let us follow through the steps in the design of a beam to resist bending moment in so far as it concerns these factors.

Let M_L represent the live-load moment (including impact) caused by the design loading. The design loading which is used with the accepted values for "working" stress is commonly one that produces about the same live-load moment as is produced by the heaviest vehicles now allowed to operate freely on the highways.

Let it be considered advisable to provide for unusual overloads and for a future increase in legal loads, by using a moment value of cM_L. The factor c, of course, is greater than unity and it is thus assumed that vehicle axle loads and groupings will increase proportionately. This is probably as good an assumption as can be made.

Let M_D be the maximum dead-load moment, due to the weight of the members plus any possible additional weight of paving, earth load, and so forth, which may be added in the future. The present practice of specifying maximum, or near-maximum weights for all materials gives results that are on the safe side, and little if any addition to the factor of safety for future increase in dead load seems necessary.

Let f be the maximum unit stress the material can stand without damage. This would be based on specified test strength values, with proper deductions to cover the normal variation in the strength of individual pieces, the effect of normal faults in abrication and erection, and the effect of possible repetitions and reversals of stress.

Let f_s be some stress value lower than f, to be determined as shown below. It will be a value like that set up in the present design specifications for "working" or "allowable" stress.

Then, for maximum safe, or "ultimate," design values,

$$M\ (= \text{resisting moment}) = cM_L + M_D = fS \quad . . (1)$$

Here S is a function of the beam section—the "section modulus" in the case of steel beams, or Kbd^2 in the case of reinforced concrete beams.

In order to compare this with the present practice of designing with a "working" stress value considerably less than the maximum safe stress (putting the safety factor in the maximum allowable stress instead of the loading), we may divide the terms in Eq. 1 by some factor, say c. Then

$$M_L + \frac{M_D}{c} = \frac{f}{c} = f_sS \quad . . . . . . (2)$$

Note that in the process of design the live-load moment, cM_L, is not affected by a change in the properties of cross section of the beam. On the other hand, M_D varies with any change in S, and S in turn depends on the value of $M_L + M_D$. The answer, as is well known, is found by the cut-and-try process. (In the case of rating an existing bridge, the values of S and M_D are known, and the safe value for M_L depends on the safe value of f.)

In Eq. 2 the live-load moment M_L is of the same order as that caused by present-day vehicle loads. However, in this case overloads, or future increases in live load, are taken care of by dividing both M_D and f by the factor c. The value of S is the same in either Eq. 1 or Eq. 2.) Present design practice divides only f by the factor.

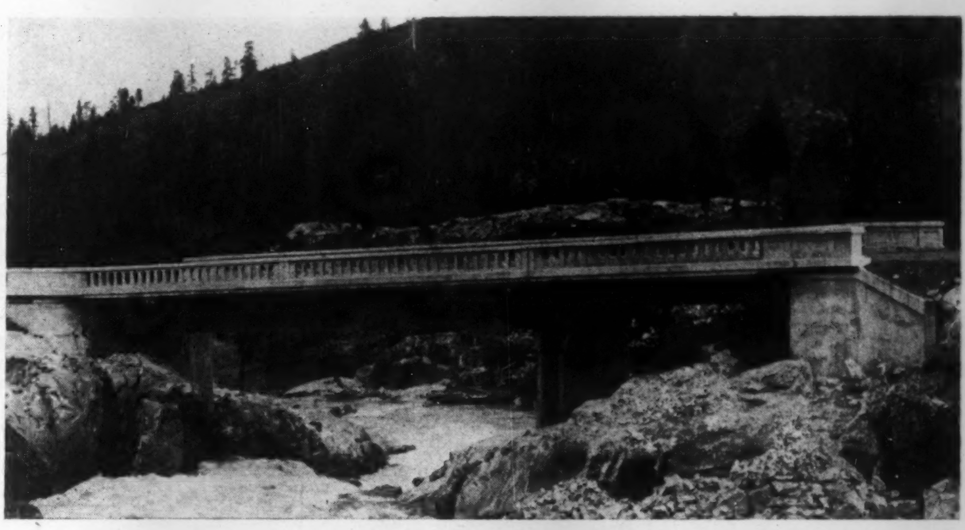
A STEEL OR REINFORCED CONCRETE BEAM TAKEN AS A NUMERICAL EXAMPLE

As a numerical example, take a steel beam, or a reinforced concrete beam in which the stress in the steel is the governing factor, and assume 27,000 lb per sq in. The A.A.S.H.O. "operating rating" maximum) to be a conservative maximum value for f. Let c be taken to equal 1.5. Then, substituting in Eq. 2,

$$M_L + 0.67M_D = 18{,}000S \quad . . . . . (2a)$$

The value of f_s thus obtained is that given in the present A.A.S.H.O. design specifications. However, only two-thirds of the dead-load moment is to be used in computing the resisting moment of a beam section, which contrary to current design practice.

The practice of obtaining a safety factor through the use of a relatively low value for the allowable stress in a given material, instead of designing for an ultimate load, seems to have had its origin in early railroad bridge design. Although it probably was satisfactory for the structural types to which it was then applied, its premises and limitations seem to have been forgotten. The practice has acquired a sanctity that cannot be justified, and furthermore it is detrimental to proper consideration of the more varied and complicated structural designs of today. It has produced structures that are generally safe under present conditions, but many that are inefficient.



A Bridge with Unequal Span Lengths, and Unequal Load-Carrying Capacity in the Spans

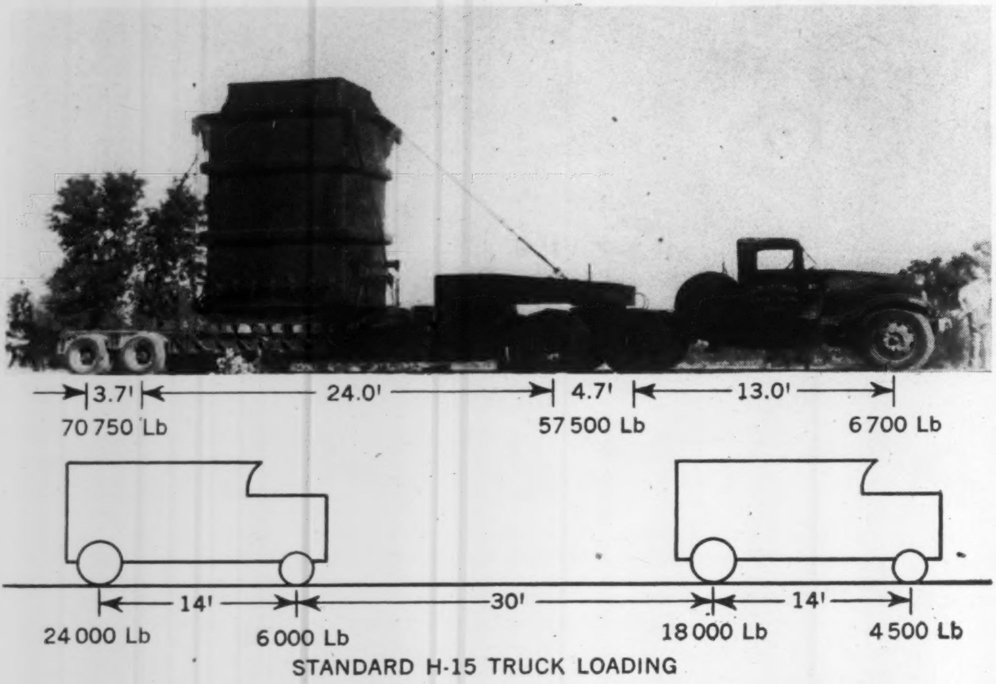
DIFFERENT FACTORS OF SAFETY FOR LIVE AND DEAD LOAD

The advisability of using a different factor of safety for dead load than for live load has been advocated before, particularly in connection with reinforced concrete structures. (See "Balanced Design for Reinforced Concrete," by Boase and Morgan, *Journal of the American Concrete Institute*, Vol. 14, No. 4, Feb. 1943.) The practical results obtained by using a logical procedure such as this may still be in error if the assumptions made in connection with the other design factors are incorrect. For example, the live-load moment produced by the H-15 loading of the A.A.S.H.O. specifications in 20-ft spans is about the same as that produced by maximum legal vehicle loads which operate in many states, but in a 50-ft span the live-load moment produced by the H-15 load is considerably below that which would be produced by these vehicles.

A large majority of existing bridges have been designed for the H-15 loading during the last twenty years but, as already mentioned, the coefficient of M_D has been taken as unity instead of a lower value, such as f_s/f. This, by increasing the ratio of M_D to M_L in the longer span lengths, counteracted to some extent the effect of a relatively light live loading. Two wrongs thus tended to make a right—owing to good fortune rather than to good logic.

Evidently it would be simpler to follow Eq. 1 and design bridges for the expected maximum future live loads, maximum possible dead-load values, and maximum safe stresses under the chosen load. This idea of designing structures with maximum values as the criterion also is not new. (See "Theory of Limit Design," by J. A. Van den Broek, Transactions, Am. Soc. C.E., Vol. 105, 1940, p. 638.) However, objections of a practical nature have been raised against this procedure:

1. The knowledge that bridges are being designed for "a future increase in live load" might bring a demand for an immediate increase in existing legal vehicle-weight limits. Truckers overlook, or do not understand, the



AN ACTUAL HIGHWAY VEHICLE LOAD COMPARED WITH A STANDAND H-15 TRUCK LOADING

fact that serious overloads will occur at any time and that an increase in the frequency of heavy loads causes progressive deterioration.

2. Although bridge engineers are content to use a live loading that has a minus "safety" factor as compared to present vehicle loads, the idea of raising allowable stresses much above traditional values upsets them greatly. This seems to hold even when the design loading is increased.

The procedure indicated by Eq. 2 has been suggested in order to get around these objections. Any decrease in strength that would result from the use of a lower safety factor for dead load than that used in the past with the H-15 loading will be more than counteracted by adopting the heavier, and more correct, H20-S16 loading of the A.A.S.H.O. specifications. Recent studies have shown that this loading produces about the same effect as the heaviest legal vehicle loads for all span lengths. (See "Pit Scale" records of the Public Roads Administration and Cooperative Analyses, made by Prof. A. A. Jakkula, Agricultural and Mechanical College of Texas.)

All this applies to spans of such length that not more than one vehicle or vehicle combination can be on a single lane at a time. If there can be more than one, then the question arises: What is a reasonable number of maximum-weight loads to assume will be on the span at the same time in exactly the critical position to cause maximum stress in any member? This does complicate the problem, but engineers are still faced with the necessity of setting some reasonable maximum condition as a basis for design. The idea now seems to be to hide one's head in the sands of "good engineering practice" and hope that if something has worked in the past it will also work in the future—even when conditions change!

OTHER ELEMENTS ENTER IN

The design of a simple beam to resist bending moment, which has been used for purposes of illustration, is of course only one element entering into the design of a highway bridge. However, it shows that in order to obtain a logical design, the effect of live-load and dead-load forces must be treated separately. Other cases have been discussed by Messrs. Boase and Morgan in the article previously referred to. It is clear that any benefit resulting from such a change in present design practice can be nullified by the use of incorrect design loadings. It is also necessary to investigate the empirical rules used in calculating stresses so as to see that natural forces not covered by the specifications (which are intended only for ordinary conditions) are not neglected.

Errors that occur because live load and dead load are not considered separately are not of the same order for every structural member. Many practical considerations besides the stress will affect the result, such as providing for lateral stiffness, limiting the amount of deflection and vibration, providing sufficient space for placing of concrete, and providing a minimum section against future deterioration.

As a general principle it may be said that more efficient structures call for greater care and labor in designing. Rule-of-thumb methods require large safety factors, and the resulting errors are often very large. Proper design and supervision of construction should not be penalized to take care of the cases where a poorer standard of engineering must be accepted. There are also cases where accurate analysis is not worth the extra time and cost. It would seem that specifications should differentiate between these two cases in a clear and definite manner.

The maximum safe load for which bridges are to be designed is, of course, directly related to the maximum safe stress in each structural member that results from applying this loading. Present knowledge of the action of forces in structures of various types and the variability in the strength of standard material may make it necessary to keep maximum stresses well below that indicated by laboratory tests. However, the load-carrying capacity will be more nearly constant if the design is based on (1) a maximum loading and (2) the highest stress values to which it is safe to go and still provide for all unknowns other than the load factor. If it is necessary to retain values for the loading and "working" stress of the same order as those now in use, a reasonably uniform safety factor can only be obtained by a proportionate reduction in the dead-load moment.

It is my opinion that, until more testing and research are done, it would improve matters if bridges were designed on the basis of a 50% increase in the present H-20 S-16 loading and the allowable stresses of the A.A.S.H.O. specifications, together with a dead load computed from the unit weights given therein. It would produce better and yet reasonably conservative bridge designs. The load-carrying capacity would be of the same order as that of bridges designed for an H-15 loading under the present specifications—not quite as great for heavy long-span bridges, but greater for the shorter spans which comprise the great majority.

Oregon Uses Lambert Conformal Conic Projection in Highway Surveys

By C. B. McCullough, M. Am. Soc. C.E., *and* H. G. Smith

espectively Assistant Chief Engineer and Construction Engineer, Oregon State Highway Department, Salem, Ore.

SURVEYORS in Oregon have found their work simplified somewhat and made considerably more accurate with the introduction of the coordinate system known as the Lambert conformal conic projection. Introduced in Oregon in 1934, the system has found increased use with the location of more and more triangulation stations on the grid. Among the applications of the control system is its use in highway surveys. This and other applications are described by Messrs. McCullough and Smith.

IT is obviously impossible to project a curved surface on a plane, or accurately to represent such surface on a plane map. Because this fact, one of the problems that esented itself early in the history mapping was the development of projection which would achieve a mpromise within the limits of curacy desired. Several methods ve been devised, each with some ality that renders it fit for a par- cular purpose.

The U.S. Coast and Geodetic Sur- y (U.S.C. and G.S.) has adopted two principal sys- ms of projection to meet this need. For those states ving their greatest dimension in a north and south ection, a system known as the "transverse Mercator" used. For those states wherein the greatest dimen- n is in an east and west direction, which is the se with Oregon, a system known as the "Lambert nformal conic projection" has been employed as a sis for the resulting plane coordinate system. This thod was developed some sixty years ago by a French ysicist, Johann Heinrich Lambert, and it is in accord- ce with this projection that the battle maps of France d Germany have been prepared.

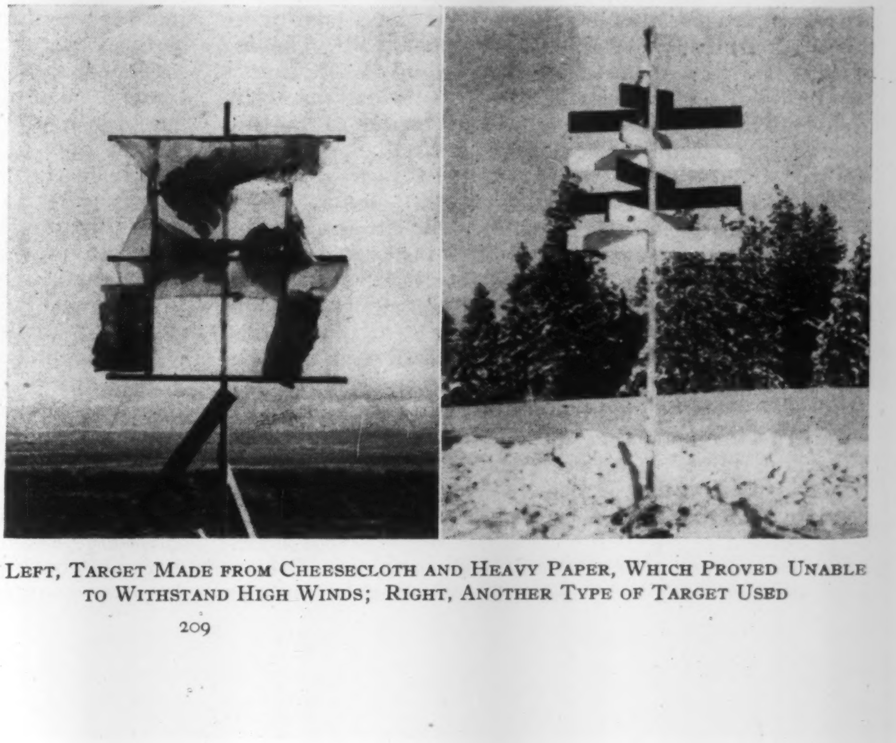
The Lambert conformal projection was first used in egon in the early part of 1934. At that time the S.C. and G.S. proceeded to develop the control data projections in accordance with this system and mputed the Lambert grid coordinates for the numer- s triangulation stations which had previously been ablished throughout the state.

In Fig. 1 the principal triangulation arcs for Oregon are licated, together with the Lambert projection zones. will be noted that that part of Oregon st of the 121° meridian, with the ex- ption of one small parcel, has been versed with first-order triangulation tworks. Quadrangle maps of this ea have also been prepared and pub- hed in final form. That part of the te east of the 121° meridian and rth of latitude 44° has been mapped the extent of approximately 50%, d control stations have been estab- hed in most of the rest of the region. at part of the state south of latitude and east of the 121° meridian has rdly been touched. There is one trol net that follows the Idaho- egon line throughout, and another t runs north from Lakeview to gontire and thence east to Burns; wever, no other triangulation has so been done in this area. In general, se parts of the state in which most the highways are located and where majority of the population lives, are covered by triangulation networks.

The Lambert conformal conic system consists essentially in the projection of the earth's spheroid on a developed secant cone. For the area to be mapped, two parallels of latitude are chosen for the traces of the secant plane. In general, these latitudes are spaced at a distance approximately equal to two-thirds of the width of the area to be covered by the maps. In other words, these standard parallels lie at a distance approximately one-sixth of the width of the area to be covered from the north and south lines of such area, respectively.

When the map is projected on this developed secant cone, it is obvious that the standard or base parallels will be true to scale. Along these parallels the map is accurate and true, but at all other points there is a certain amount of error. The maximum error occurs at a point halfway between the parallels and at the extreme edge of the fringes north and south of them. Error is not introduced by extending any map in a westerly or easterly direction, except such as pertains to azimuth. (The azimuth correction will be discussed later.) A single projection for the state of Oregon would permit a maximum error of one part in 5,000; this obviously should not be permitted in connection with field work, which has been held to a maximum error of one part in 10,000 and a probable error of one part in 30,000. For this reason, the state has been divided into two zones, which increases the accuracy to one part in 15,000.

The use of two zones, or secant cones, for the state obviously results in the establishment of two separate



Left, Target Made from Cheesecloth and Heavy Paper, Which Proved Unable to Withstand High Winds; Right, Another Type of Target Used

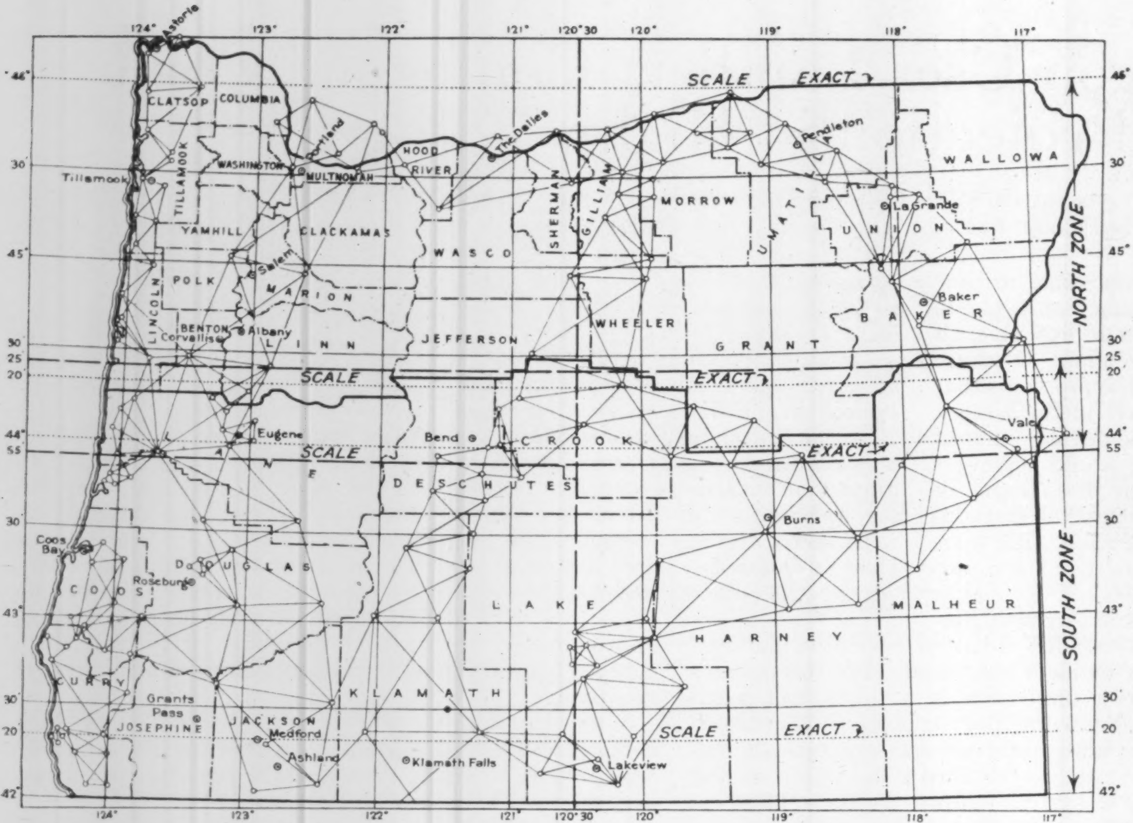

SCALE EXACT
NORTH ZONE
SOUTH ZONE
Astoria
Tillamook
Portland
The Dalles
Pendleton
La Grande
Salem
Albany
Corvallis
Baker
Eugene
Bend
Vale
Burns
Coos Bay
Roseburg
Grants Pass
Medford
Ashland
Klamath Falls
Lakeview
CLATSOP
COLUMBIA
TILLAMOOK
WASHINGTON
MULTNOMAH
HOOD RIVER
SHERMAN
GILLIAM
MORROW
UMATILLA
WALLOWA
UNION
YAMHILL
CLACKAMAS
WASCO
POLK
MARION
LINCOLN
BENTON
LINN
JEFFERSON
WHEELER
GRANT
BAKER
CROOK
LANE
DESCHUTES
DOUGLAS
COOS
LAKE
MALHEUR
HARNEY
CURRY
JOSEPHINE
JACKSON
KLAMATH
124°
123°
122°
121°
120°30
120°
119°
118°
117°
46°
45°
44°
43°
42°
30
25
20
55

FIG. 1. PRINCIPAL TRIANGULATION ARCS IN OREGON SHOWN IN THE LAMBERT PROJECTION ZONES

sets of coordinates which cannot be combined. In order to overcome this difficulty, the zones were made to overlap sufficiently to provide a belt extending over the central part of the state in which either the north or south coordinates could be employed. The southern boundary of the northern zone has been established at latitude 43° 40′, and the northern boundary of the southern zone at latitude 45° 00′, which affords an overlap of 1° 20′. For the northern zone, the standard parallels are located at latitudes 44° 20′ and 46° 00′. For the southern zone, latitudes 42° 20′ and 44° 00′ are used. (See Fig. 1). The control meridian has been established at longitude 120° 30′ and for this point the *X* coordinate has been arbitrarily assumed at 2,000,000 ft. The use of this arbitrary value places the origin of coordinates out in the Pacific Ocean. However, its use results in giving all *X* coordinates in the state a plus sign; thus providing for simpler calculations and reducing the possibility of those errors which are apt to arise when coordinates are changed from plus to minus.

In regard to azimuths, it will be noted that the plane or grid azimuth is always referred to the central or controlling meridian and does not correspond with the geodetic or true azimuth except at this particular point. As the longitude is increased east or west of this controlling meridian, the grid azimuth will diverge from the true or geodetic azimuth by a small angle because of the convergence of the meridians, since all grid azimuths are parallel to the controlling meridian. For each minute of longitude, tables have been computed by the use of which grid azimuths can be converted into corresponding geodetic azimuths, or vice versa, with a minimum of computation.

Before adoption of the Lambert system in Oregon, surveys were made and azimuths corrected by observations on Polaris, or the sun, which many times entailed a laborious and time-wasting procedure. This necessitated the proportioning of meridian convergence throughout the line, so that a line which was actually tangent on the ground became curved with respect to its azimuth. This difficulty is eliminated by the use of the grid system, since there are no corrections to be applied. In other words, in reference to a system of rectangular coordinates, the azimuth for a straight line remains constant throughout its length.

All triangulation and most traverse stations established by the U.S.C. and G.S. in Oregon are equipped with what is known as "azimuth marks," which are short courses leading from the triangulation or traverse point to some local monument, the azimuth of which course has been predetermined. Local surveys may, therefore, be initiated by obtaining the grid azimuth for such an azimuth line, thus eliminating the necessity for an observation on the sun or on Polaris.

MORE AND MORE SURVEYS TIED IN

For the first few years after the inauguration of the Lambert conformal projection system, surveys of the highway department were tied into the triangulation stations only where such a procedure was found convenient. During the past few years, however, an effort has been made to tie all surveys into the Lambert grid system and to make all computations conform to it. It has been somewhat difficult to tie all these surveys down, owing to the wide spread between triangulation points, to the inaccessibility of some of the points and especially in western Oregon, to low visibility occasioned by fogs and haze.

As more of these surveys are tied into the Lambert system, a smaller network is achieved, and eventually it will be possible to tie highway surveys into the Lambert grid at any point with a minimum of effort. Although the type of triangulation done by the state highway survey parties has been rated as "third-order," its accuracy is in reality comparable with that of second-order standards.

Oregon's experience with the Lambert grid has conclusively demonstrated the fact that in actual practice it expedites both field and office work on location surveys. It also operates to eliminate any field errors, which under the old system of location remained unknown until actual construction was commenced. As soon as any preliminary line is run and ties are made at both ends (and possibly at intermediate points), the closure of the traverse can be computed; and if such closure is not within allowable limits, an immediate check-up can be made before the error is carried on or continued into the located line. If and when such closure is found to be within allowable limits, the adjustment of the traverse may be computed and projections laid with mathematical precision. Ties between the preliminary and located lines, computed at frequent intervals, enable the field party to check on their work as they progress and thus to pick up and correct errors which might otherwise be continued for long distances and entail considerable retracing of the line. Such retracing, especially in timbered and mountainous country, can prove very expensive.

Because the preliminary and located lines can be accurately tied to each other, field parties are able to proceed at once with the tying in of section corners, property corners, and the like. They can also secure such other data as must be used on the located line without waiting for the office projection or for the field work of running in the located line on the ground. Such a procedure frequently permits full utilization of a field party, which otherwise would be idle or working at minimum efficiency during certain stages of the survey.

By means of the computation—and subsequent placement on the finished maps—of the grid coordinates for all property corners, section corners, and so on, as well as the coordinates of all tangent intersections and other critical points along the highway alinement, it is obviously possible at any future date to reestablish such points with a minimum of effort. Further, this assures that any points replaced are in their exact original position.

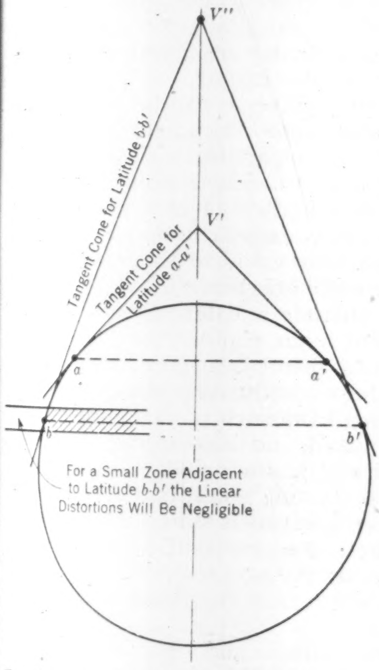
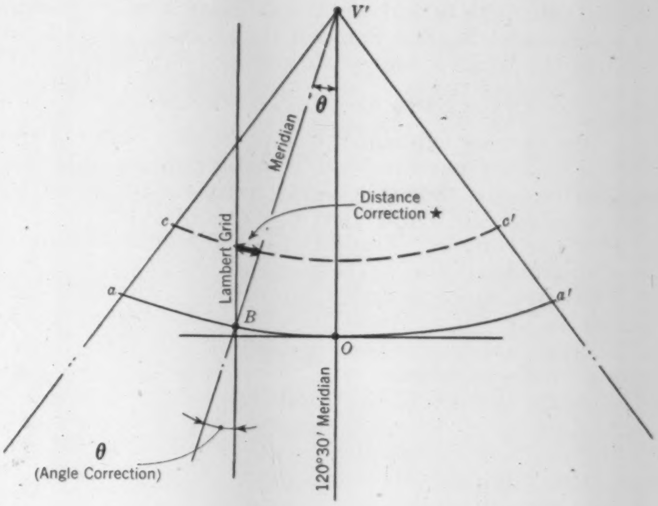

V''
Tangent Cone for Latitude b-b'
V'
Tangent Cone for Latitude a-a'
a
a'
b
b'
For a Small Zone Adjacent to Latitude b-b' the Linear Distortions Will Be Negligible

Fig. 2. Principle of Lambert System, Shown by Intersecting Sphere and Cone

Office work on location is greatly facilitated by use of the Lambert grid system. With the methods in use before this grid was adopted, it was frequently found that the preliminary line and the final located line could not be reconciled within a reasonable degree of accuracy. Then a new set of coordinates would have to be set up for the located line, and since these did not correlate with the preliminary coordinates, all field ties would have to be remade. The writing of right-of-way descriptions is also simplified by use of the Lambert grid.

For a short time after the Lambert system was first introduced in Oregon, the work of running primary traverse lines between U.S.C. and G.S. stations, as well as the work of computing the coordinates and grid azimuths, was carried on as a joint project between the State Highway Department and the Survey. A relatively small crew of men was employed for this purpose and only a small amount of funds appropriated for the work. With the exhaustion of these funds, work was closed down. However, the State Highway Department a little later reestablished the project and continued the computation and clerical work necessary to keep the grid system up to date and in workable condition. During recent years this work has been carried forward, and as more and more field surveys have been tied into the Lambert grid, the State's records have become correspondingly more complete.



★ This Correction Is Shown in the Last Column of the Projection Tables, Opposite the Latitude of the Point in Question

Fig. 3. Developed Cone Superimposed on Rectangular Grid

INFORMATION DISPENSED TO ALL WHO REQUEST IT

At the present time the Highway Department serves more or less as a clearing house for information of this character, and disseminates it to various interested state, county, and governmental agencies. A rather complete file is maintained and information is dispensed to anyone who requests it. Several federal agencies, particularly the Army and the Bureau of Reclamation, have utilized the State's surveys in promoting and developing their own. In one instance, the North Unit Irrigation Project in Jefferson County, the Reclamation Service saved considerable time and effort by using various traverses and points established on the Lambert grid by the State Highway Department. During recent Army maneuvers in central Oregon, various parties of topographical engineers also made use of the data previously compiled by this department.

The ability to reestablish beyond dispute landmarks which have disappeared and property and section corners lost or destroyed will be of inestimable value to property owners in the future. Particularly is this true in certain logged-off areas of the State where scribed stakes used for section and property corners have rotted away, and bearing or reference trees have been destroyed.

Many section corners and other landmarks have been reestablished since the State was first sectioned (about 1870), but in many cases permanent ties were not made. This has resulted in costly resurveys, and has been the basis of numerous lawsuits and property disputes. The use of the Lambert grid system will eliminate all this, since any point once tied in can be reestablished with a minimum of effort.

In order to acquaint the State's locating engineers with the Lambert system, a circular letter was recently sent to them. The purpose of this was to explain the fundamental principles underlying the utilization of the system as applied to Oregon. Some of these observations have a general application and so are included here.

THEORY AND PROCEDURE SIMPLIFIED

As the circular explained, it appears that many of the State's locating engineers are reluctant to use this system in the belief that it is highly technical and involved and requires the employment of complicated mathematical derivations. This latter conception is erroneous, as the Lambert grid system is in reality based on some rather simple concepts.

Its application may be explained rather briefly as follows:

Since the surface of the earth is curved, no system of rectangular coordinates drawn upon a plane can be used to represent distances and angles without introducing some error, since the only region over which the curved surface and the plane surface coincide is at the point of tangency of plane and spheroid. However, since the radius of the earth is comparatively large, the error introduced throughout any small region adjacent to this point of tangency would be comparatively small.

To develop the idea, consider Fig. 2, wherein the circle represents approximately a cross section of the earth. If at any point along a parallel of latitude, such as a-a', tangents are drawn in the various meridian planes, these tangent lines or elements intersect the polar axis of the earth at some point v to define a cone v'-a-a'. In a similar manner, tangents may be drawn from the extremes of any other parallel of latitude such as b-b' to define a second cone v''-b-b'. In any comparatively small region adjacent to these parallels, the surface of the earth and that of the corresponding cone are nearly coincident.

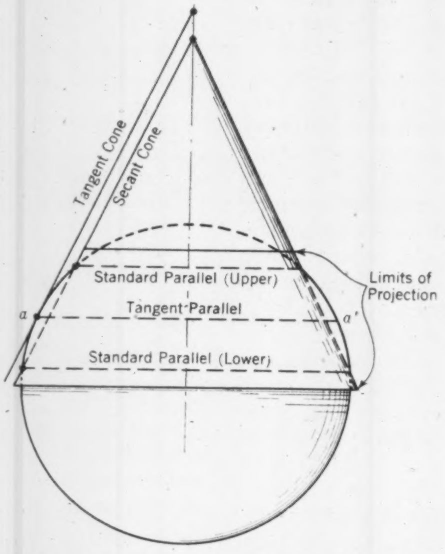


FIG. 4. SECANT CONE ESTABLISHES LIMITS OF PROJECTION

LAMBERT GRID SUPERIMPOSED

Let us now develop the cone v'-a-a' as shown in Fig. 3, and with the point O as origin, superimpose on this developed surface a system of rectangular coordinates, such as the Lambert grid. It is apparent that at point O there is no distortion either linear or angular. It is also apparent that along the parallel of latitude a-a', there will be no distortion in distances or linear measurements. However, at any point east or west of the origin O, for example at point B, there will be an angular distortion, θ, since the geodetic or true meridans converge at the pole, whereas the Lambert grid lines are parallel. On any parallel of latitude north or south of the parallel of reference a-a' (for example, c-c'), there will be not only an angular distortion correction, but a correction in distance (Fig. 3).

These are the basic principles underlying the Lambert system; however, in order to secure even greater accuracy, the Lambert grid is referred not to a tangent plane, but rather to a secant plane, as indicated in Fig. 4, so that instead of one parallel of latitude (such as a-a') along which there will be no linear distortion, two "standard parallels" are furnished within the limits of projection as determined by the "secant plane." The error in angle or in distance on the Lambert grid may be disregarded and the rectilinear coordinates may be used without appreciable error.

The system of Lambert coordinates has been devised to provide a tie between local plane coordinates and the more elaborate system of geodetic control which takes into account the curvature of the earth. The U.S.C. and G.S. has established a national system of triangulation which provides stations for nearly every locality and enables the local engineer to expand his surveys over greater distances and still provide correct azimuths throughout his traverse. By checking on other triangulation points in the vicinity, he automatically checks his traverse and thus avoids the necessity of closing it on the starting point.

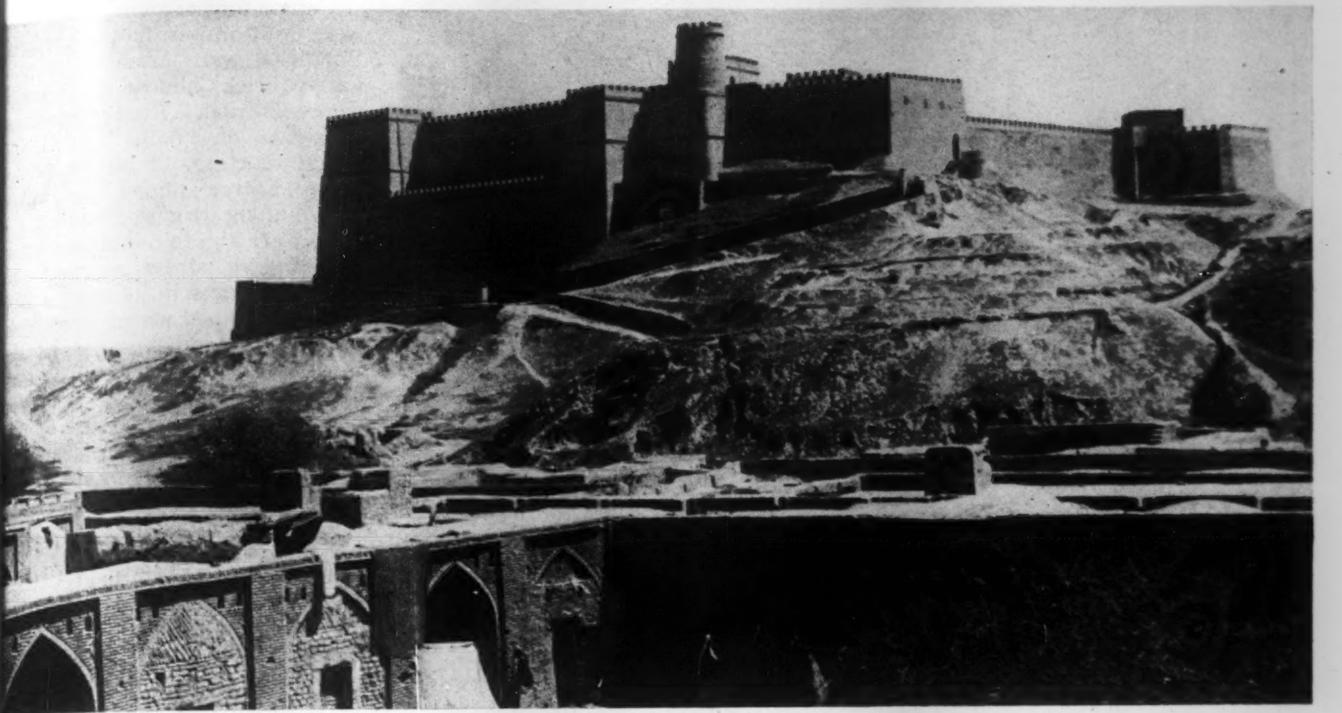
Known triangulation points have been set by reliable organizations like the U.S.C. and G.S., the U.S. Geological Survey, and U.S. Corps of Engineers, the U.S. Forest Service, and the Oregon State Highway Commission. The points are a part of some network of triangulation and their latitudes and longitudes have been determined with considerable accuracy. The geodetic or true azimuths of lines radiating from any of these points have also been computed accurately so that the engineer can feel confident in using this information for his surveys.

In order to use the Lambert system, some triangulation point whose coordinates are known must be tied into the survey. From that point on a traverse can be continued indefinitely and its coordinates computed by the usual method of latitudes and departures. Such a traverse will always remain on the Lambert projection. With suitable tables, the coordinates of any point on the traverse can be transformed into latitude and longitude, but this is of no particular value to the engineer. He can use the Lambert coordinates best.

For field use the latitude and longitude of any triangulation station which an engineer may use in his survey are transformed into plane coordinates on the Lambert grid; and these coordinates, as well as the azimuths of lines radiating from such point to other known points, are all determined and can be easily obtained from the State Highway Commission. Using these x and y coordinates as a starting point, and using the grid azimuth to some other point as a starting azimuth, the latitude and departure can be computed for each point on the traverse as the survey progresses. The latitudes increase toward the north and the departures increase toward the east.

Detailed instruction, tables, and other data are also given in the circular. They will be furnished on request to anyone interested in delving more deeply into this subject.

The derivation of the formulas for the solution of the constants used in this system of projection will also be found in Special Publications Nos. 47 and 52 of the U.S. Coast and Geodetic Survey. Further computations and applications will be found in Special Publications Nos. 67, 68, 71, 145, 193, and 194.



Signal Corps Photo

NATIVE VILLAGES SUCH AS THIS DOT THE LANDSCAPE ALONG THE IRANIAN RAILROAD, SUPPLY ROUTE TO RUSSIA

Versatility Marks Work of Persian Gulf Command

By E. B. MYOTT, M. AM. SOC. C.E.

LIEUTENANT COLONEL, U.S. ARMY, COMMANDING ENGINEER GENERAL SERVICE REGIMENT

"I WILL always remember Iran as an absolutely barren country of excruciating heat.... But, most vividly of all, will I always remember the matchless, unconquerable, grim determination of the technically trained American soldier in Persia...and how his unstoppable effort perhaps meant life itself to our great ally, the U.S.S.R." From his vivid memory of the work of the Engineers in Iran, Colonel Myott prepared this tribute to their effort. It was presented as an address before the New Orleans Section of the Society.

SO great was the need for all sorts of facilities in Persia when the first Army Engineers went into the area, that the versatility of these units was drawn upon to the utmost. Consider the situation they encountered. Let's start with the war situation in the summer of 1942. The Germans were knocking at the gates of Stalingrad. Russia was fighting for her very life—and at that time many believed for the life of the Allies too. Russia needed arms—food—medicine—raw products — clothing — aircraft—motor vehicles and much heavy mechanical equipment. And the only way those precious materials and equipment could reach the desperate Soviets in quantity was by developing lines of communication for transportation across Persia, and to such an extent that the project sounded fantastic. Lines of communication stretched endlessly across scorching, heat-blistered deserts in temperatures of 125 F and more, through mountain gorges and over mountain passes. The proposed lines would have to be developed by new construction and improvements requiring equipment and materials that did not exist there, and also with labor that did not exist there. First, existing ports had to be enlarged and new ports built to handle the vast tonnages of cargo and equipment involved.

Specifically, the job of the Army Engineers was to make possible the movement of cargo by both rail and motor transport across the Persian corridor to points in Northern Iran in the Caspian Sea area. This was a distance comparable, roughly, to that from New Orleans to southern Illinois.

Before the job could be started, adequate port facilities had to be constructed, and time was short. Troops and critical war materials were already under orders in the States, destined for this area. This was a long way at that time, incidentally, because they had to come more than 17,000 miles, down along the Atlantic Coast, across the Atlantic, and on around the Cape of Good Hope—a tremendous distance, and almost every mile or, say, every wave of the way, through potentially submarine-infested waters.

DOCKING FACILITIES

The ship-docking facilities provided consisted principally of quay wharves along the shores of the Shat-el-Arab River, which is formed by the confluence of the Tigris and the Euphrates. These wharves were of timber construction and were served by rail. The port of Basra is served by the narrow-gage Iraq State Railway, extending from Basra to Baghdad, and the port of

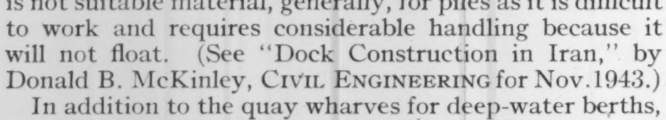
Signal Corps Photo

TRACK CAR FINDS TROUBLE ON IRAN ROUTE BEFORE IT HAPPENS

Khorramsharr by the standard-gage Persian Railroad. The wharves are equipped with traveling cranes having capacities at normal working radii varying from 3 to 15 tons. Consequently cargo was discharged from ships at rapid rates.

One of the interesting construction features of the wharves—to me, at least—was the use of some teakwood piles spliced to provide a length of about 90 ft. Teakwood is not suitable material, generally, for piles as it is difficult to work and requires considerable handling because it will not float. (See "Dock Construction in Iran," by Donald B. McKinley, CIVIL ENGINEERING for Nov. 1943.)

In addition to the quay wharves for deep-water berths, several lighterage wharves were built. These were of considerable value, as they enabled cargo to be off-loaded into barges at the same time the ship was discharging at a berth. Both ports were equipped with floating cranes and stationary derricks for handling heavy loads such as railroad locomotives.



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NATIVE LABOR UNLOADING AMERICAN FLOUR FROM BARGE

Some Cargo Was Off-Loaded Onto Barges While Ships Were Discharging Other Cargo at Deep-Water Berths

Camps for personnel at the ports were built on low, flat, desert land. Barracks were usually built of native brick, almost all of which were sun dried. Roof construction consisted of "ballie poles" and native matting. Ballie poles are green native poplar, or willow grown along irrigation ditches; the poles were $2^1/_2$ to 6 in. in diameter. The native straw matting was covered with 4 in. of mud, a mixture of chopped wheat straw being used as a binder. Some of the roofs were even water-proofed by applying asphalt. The insulation was needed badly because of the blistering heat. Occasionally we saw it reach 140 F in the shade. As for the nights, very often the temperature failed to go below 90 F.

Soldiers engaged in unloading ships, and in many other activities, are known to have worked in the sun when the temperature reached a maximum of 180 F. Most activities, however, were suspended during the first part of the afternoon on account of the heat.

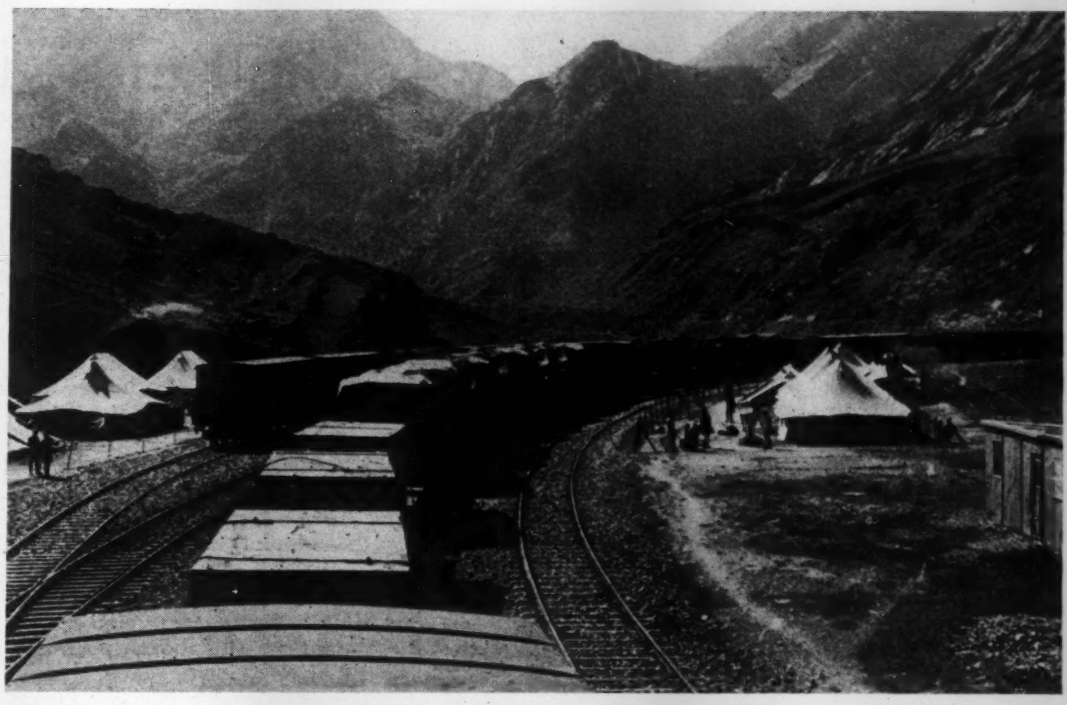
The principal line of transportation to Russia was the Persian Railroad, built by the Shah some years ago as a transportation link between the Persian Gulf and the Caspian Sea. The railroad was of standard gage and single track, and extended across the desert land, over the mountains of Central Persia, across the southern end of the Great Plateau of Northern Persia, and then across more mountains to the Caspian. There are 133 tunnels in one section having a length of only 110 miles. In another section only 185 miles in length, the elevation of the railroad increases from 300 ft to 7,250 ft above sea level.

At the time it was decided that our Army would take over the operation of this railroad, most of the rolling stock was in very poor condition. Many railroad locomotives and cars had to be shipped from the States to supplant and augment the existing equipment.

A fine record was made by our operating battalions on this Persian Railroad. When these soldiers return they will have tales of running trains through tunnels at temperatures which could not have been any more sizzling even in hell! They can also tell—and it won't be any tall tale, either—how the amount of cargo was increased several hundred per cent over the amounts moved by their predecessors. As a matter of fact, about the only way any more cargo could have been moved over this line would have been by double-track construction for its entire length.

The movement of cargo by motor transport from the Persian Gulf ports necessitated the construction of several large camps for housing personnel engaged in the trucking operations, large maintenance shops, fuel facilities, 170 miles of highway across the desert, and widening and improvement work on about 500 miles of highway, a large part of which was over high mountain passes.

Much has been written about the operation of motor transport over the Burma Road, but very little publicity has been given to the motor transport route across the Persian Corridor. This was a large and very successful undertaking. The route of operation, 650 miles in length, was divided into four blocks. Main camps were



Operation of Iranian Railroad Was Assumed by the Army Service Forces Transportation Corps

onstructed at the end f each block, with inermediate camps in ach block. Most of he personnel lived at he main camps, and ll truck maintenance ork was performed here. The intermeiate camps were arge service stations, nd equipped for servng meals to the truck rivers.

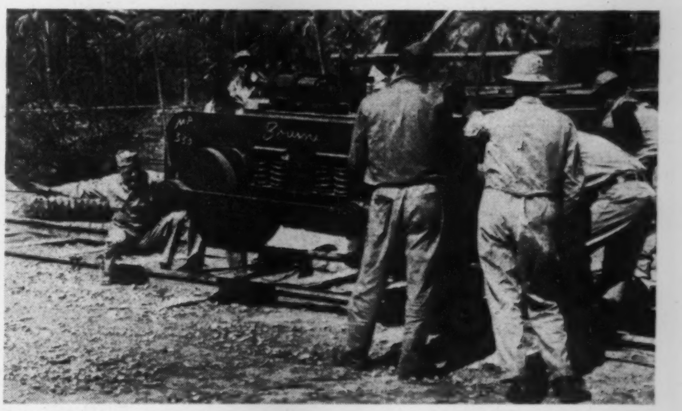
Trucks were kept in ontinuous operation xcept for such time s was required for ervicing and repairs. ll trucks were moved n convoy formation, nd strictly in accordnce with time chedules similar to hose used in railroad peration. This close ontrol of operation as necessary to keep he density of the raffic to a minimum. The main highway route was also sed by the British and the Persians.

After completion of improvements, the highway was f ample width to permit two-way traffic. During the rst year of operation and during the construction of the 70 miles of the new highway, traffic was moved over esert tracts. A large part of the old road only had a ravel surface, but practically the entire length of the ighway now has either an oiled or a light asphalt surace.

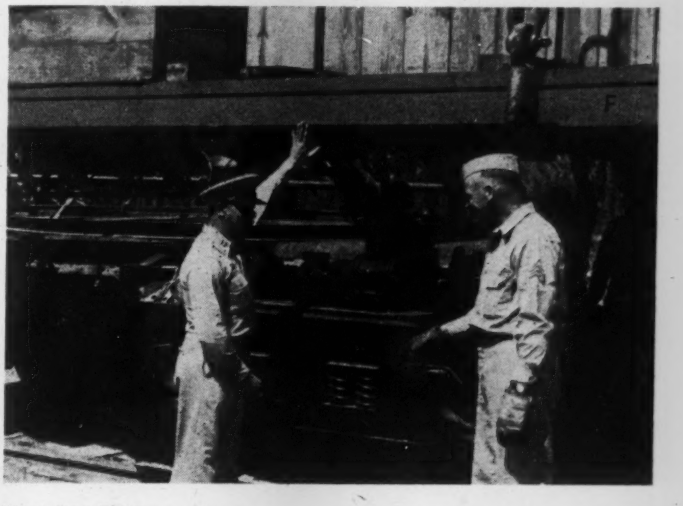
For many miles the highway extends through narrow alleys and gorges and there are many extremely sharp, inding curves. There are two mountain passes at an levation of about 8,500 ft above sea level. There are any hills with a maximum gradient of 12%. The peration of trucks over this route involved all climatic roblems, ranging from extreme heat and dust storms the desert, to deep snow drifts at temperatures of 10 to 5 F below zero over the mountain passes. Many landides blocked the highway through the mountain gorges uring periods of intense rainfall in the spring.

In addition to the highway and railway work, and the onstruction of wharves, camps, hospitals, shops, and epots, aircraft and motor-vehicle assembly plants were onstructed, and many thousands of trucks and aircraft ere assembled as they arrived from the States "knocked own." The Signal Corps of the Army likewise did a eat deal of construction. They built miles of telephone nes and provided many radio installations which were ssential to the operation of the ports, the motor transort routes, and the railroad.

The use of natives in the motor transport operation, well as for stevedores at the ports and laborers on the ilroad and in the assembly plants, presented many oblems. At any rate, whatever their faults, the use of ese native laborers proved highly successful and conibuted inestimably to our success—not even excluding e bandit tribes occasionally found along the way. t least they provided a touch of novelty and a promise excitement, which perhaps helped the American soldiers get through an otherwise monotonous task.



Rear Truck of a Diesel Locomotive Being Lowered by Crane Onto the Tracks of the Iranian Railroad



Signal Corps Photos

Diesel Body for Iranian Railroad Is Lowered on Its Trucks Before Being Uncrated

Guam Superhighway Built in Sixty Days

High-Type Roads Provided for Island Naval Base

By W. O. HILTABIDLE, JR., M. AM. SOC. C.E.
COMMODORE, CEC, U. S. NAVY

FROM a narrow, muddy, bull-cart trail to a four-lane superhighway in 60 days would be an accomplishment even under normal circumstances. It is especially remarkable under combat conditions on a recaptured island in the Pacific. Captain Hiltabidle, who was the officer-in-charge of the Seabee battalions on this road building job, describes the difficulties encountered, the work done, and more than that—the spirit which worked this construction miracle.

TO Seabee battalions landing with Marine assault forces on Guam went the "impossible" job of lacing the strategic island with superhighways and feeder roads as a preliminary to building it up into a western "Pearl Harbor." The Japanese had 30 months of possession to do the job and failed. The Seabees started with three strikes against them: (1) the rainy season was on; (2) invasion battle was at full tempo; (3) it was a road job different from, and more difficult in character than, anything previously attempted in the Pacific.

This first U.S. island to be retaken from the Japanese is not one of the myriad, dune-like atolls used to springboard the assault across the Pacific but is a sprawling, rugged island running 30 miles in length and averaging 10 miles wide. The northern shoreline rises precipitously out of the sea to 400-ft cliffs. From this lofty region, limestone plateaus slope down to rough, jagged hills of red volcanic clay and swamps in the south.

Facilities built here would not be of the type to serve a temporary military need but would be permanent in nature. As stated by Marine Island Commander, Maj. Gen. Henry L. Larson, "Guam will be rebuilt into a kind of 'Pearl Harbor.'"

EXISTING ROADS DEEP IN MUD

On "D-plus-one" the road building job began. Marines had made simultaneous thrusts at both ends of Apra harbor, situated on Guam's west central side. Apra is the only deep-water anchorage on the reef-circled island. From beachheads at Agat to the south and Asan to the north they began a pincer drive toward Orote peninsula. The lanes skirting Apra harbor had to be opened to carry the inflowing supply tonnage. Swath-cutting bulldozers moved in (after having helped tow General Sherman tanks through the surf from reef-stalled LST's) and began pioneering work. The former two lanes of thinly surfaced cascajo had been torn and rutted by pre-invasion bombing and were now deep in mud—the rainy season's by-product, which the Japs had given up trying to beat. What remained of the road was hardly suitable for native bull-cart travel.

Out of this bomb-pocked, quagmired stretch, Civil Engineer Corps officers took meditative appraisal of the job ahead. Because Guam was to be developed as a major base, the highway specifications laid down by the Fifth Naval Construction Brigade were as rigid as those for super roads in the States.

Main arterials were to be widened to 56 ft, super-elevated, and made to carry four 11-ft lanes. The strips were planned wider than some standards in the States to allow for oversize military vehicles. Turns on the main routes were not to exceed 6 deg, and grades were to be held to a 6% maximum. This meant that cuts up to 95 ft would have to be made through hills of hard limestone rock and coral. A minimum sight distance of 800 ft was to be maintained. A complexity of drainage systems would have to be laid to handle the torrential rains. Surfacing would be $2^1/_2$ in. of asphaltic concrete. Roads leading off the main highways would carry three and two lanes, but this reduction in width would not relax any of the other rigid criteria. When completed, the road network would total more than 100 miles.

TYPE OF BRIDGE USED ON NEW ROAD AT STREAM CROSSINGS
Old Winding Route at Left

By the evening of "D-plus-two," pioneering gangs had filled shell holes, expanded working space, and received more equipment, now able to move in. Carryalls, 14-yd semi-tractor trailers, diesel shovels, draglines, 7-ton rooters—all crawled to the job in the traffic procession that was growing to almost unmanageable volume. Every pound of the tonnage being unloaded in the harbor had to move along this road en route to front lines and camp areas being established in secured zones.

This constant, two-way traffic made construction progress almost impossible at some points. As soon as pioneering gangs made a section negotiable, would be cut up and churned by cleat-treaded tanks, cargo trucks, and heavy equipment moving under its own crawling power to other Seabee job sites.

As the Marines advanced and opened additional road mileage, it became apparent that more equipment was needed—and could not be had. Some of ever reached the shore. Early combat damage and hallow-reef operations were taking a toll. So were demotion charges buried by Jap "booby" experts. Four D-8 cats" had their 25-ton "innards" blown out. One operaor was lifted to the treetops by concussion. A short while ter his bandaged figure was seen zealously pushing nother "cat."

By working around the clock—at night under glaring oodlights and by day under intermittent broiling sun and renching showers—the tenacious pioneering gangs managed to keep the endless traffic moving and their conruction on schedule.

CONSTANT DELUGE

The torrential rains reduced every new cut to an evereepening gumbo and made the problem of fill acute. t one point where an 18-ft cut was being made, engieers expected to use the excavated coral for filling the oad ahead, but after carryalls had taken a few top bites hey ran into soft clay. To meet the pressing call for ll—and more fill—a second coral pit was opened near iti to supplement the one opened on "D-plus-three" ear Sumay. Tractor-trailor trucks hauling from the its had their 14-yd capacity heaped to 16 yd or better, nd pushed through the morass in caravan fashion to eet the demand.

Road spots where fill just disappeared into the mud and hreatened traffic stoppage gave hard-pressed "cat" perators the added job of crashing around them and reating detours. Natives whose little palm-frond omes stood in the way had to abandon them, often on 0-min notice. Buildings of clay and brick that could ot be pushed over with bulldozers were pulverized by emolition crews.

Breakdowns on equipment were coming more rapidly. Cats," shovels, and trucks, cranked up on D-day, had opped only for quick grease jobs. Many of the heavy ieces had gone through previous campaigns. Secondring operators replacing those sickened with fever idn't know all the nursing tricks. Roving mechanics ound their job getting beyond control, and a shop apable of major overhauls had to be set up.

Japs who had withstood the initial Marine sweep bean to come out of their caves and open a new bag of arassing tricks. They sniped from coconut trees, arsh reeds, spider holes, but their prized equivalent to abbits-in-the-hat was a long bamboo pole to which hey would tie a fused TNT block. Hiding in thick oadside foliage, they would await a vehicle's approach, nd when the front end came abreast of their position hey would swing out the charge. Riflemen riding board equipment caught onto this one fast and were not ng in cleaning out the roadside Houdinis.

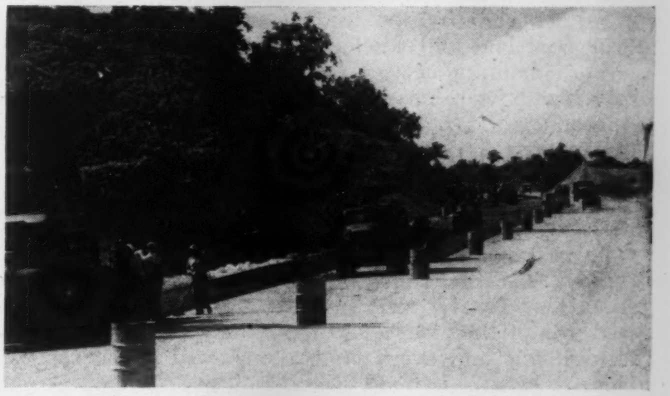
LITERALLY A TRUCK TRAIN

Slashing the road through the rolling hills between umay and Piti gave Seabee Engineers their toughest roblem in traffic management. Detours had been esblished on both sides of the intended cuts, but mileng stalls began to collect where overloaded cargo trucks ould not climb the grease-like inclines. There were not nough "pushcats" available to handle the growing line, trucks were lashed together in strings of 12, and when a cat" succeeded in getting the leaders to the top, those oing down pulled the others up. Sectors where water ad collected wheel deep, were negotiated in similar anner.

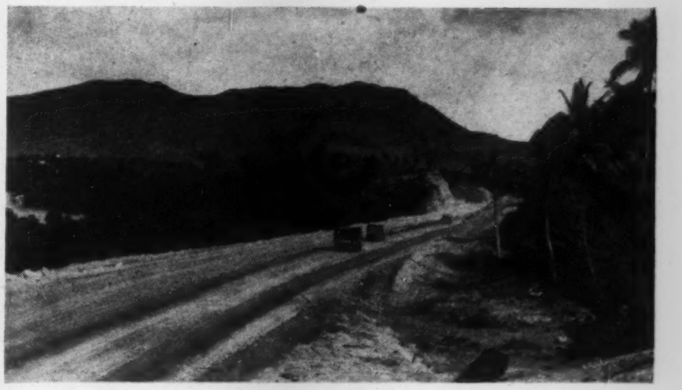
Progress through the hills was being made rapidly till e hill proved too solid for cutting with shovels and rryalls. It had to be "shot" with deep charges, but

Mine Clearing Was First on the Seabees' List of Operations

The Old Road Which Invasion Forces Found—the Best the Japs Could Do in Their 30 Months of Occupation



A $2^1/_2$-In. Asphaltic Concrete Surface Being Placed Over Coral Base



Section of the Four-Lane Superhighway on Guam, Ready for Surface Course

Deepest Cut Encountered on Guam Route Was Through This 94-Ft Limestone and Coral Barrier

drilling equipment was not immediately available. A well-digging rig was hauled to the site. Within a few hours blasters had 40-ft holes ready for charging.

Truck drivers carrying fill from the cuts to a central dump never knew when a shrapnel shower was coming their way. The dump contained scraped-up Jap land mines and ordnance that would sometimes explode when jarred or exposed to the sun's heat. A Brooklyn driver commented that the barrage of wild shots reminded him of "Coney Island shootin' galleries on Ladies' Day."

By three weeks after D-day, the 12-mile shoreline route from Sumay switch to Agana, Guam's capital city, was under construction and teeming with traffic. A motor pool had 200 trucks running day and night delivering incoming cargo. Hundreds of Marine and Army trucks were in constant operation. And to meet the road's coral requirements, 85 trucks were hauling 7,000 cu yd a day.

CORAL THOROUGHLY COMPACTED

A high expenditure of coral was necessary where the road was built across gullies, swamps, and former rice paddies. These sections took beteeen 10 and 18 ft of fill in contrast to the road's average of 4 ft. Although speed was of the essence, so were the specifications, and the high fills had every layer compacted by sheepsfoot rollers to secure permanent stability. Top fill of select coral, which averaged 12 in. in depth, had each 4-in. layer compacted.

At the end of 60 days, after the toughest kind of fighting against nature—and the enemy—the entire length of the shore route was cut, and pioneer gangs that had blazed the trail were now clearing feeder roads for tank farms, storage depots, and bomb dispersal areas. In those torturous 60 days, mountains had been cleaved, bridges built, swamps filled, and former winding sections made arrow-straight. Natives, trickling back from battle refuges in the hills, were incredulous upon seeing the transformation. Where narrow muddy trails had existed now stretched a coral-hard, four-lane super-elevated speedway reminiscent of those seen in California chamber of commerce brochures.

The "impossible" was now ready for blacktopping. (This major task of paving has since got under way, and several miles of double-lane, $2^1/_2$-in. asphaltic concrete are already in place.)

AN EXTRAORDINARY RECORD OF ACCOMPLISHMENT

Statistically, this is what Seabees and their Civil Engineer Corps officers accomplished in putting through the 12 miles of four-lane highway between Sumay and Agana:

The old road had some 85 bends, many of which were of the sharp hairpin variety, with curvatures between 15 and 25 deg. Sixty of these turns had been eliminated and the remaining 25 had been reduced to the point where only two had curvatures of as much as 6 deg Eleven were 5%, three were 4%, and the rest were 3% or less. The improvement summed up as a 70% reduction in the number of curves and a ten-fold reduction in the sharpness.

On grades, there remained only 21 points not at zer level. The steepest climb was $5^1/_2$%. The remaining 2 grades were 4% or less. To attain this minimum o grade, the crews had made nine cuts—ranging betwee 15 and 94 ft—some through solid limestone and cora hills.

The road crossed 54 drainage points, 45 of which wer handled through culverts. The other nine drainag points required bridges built to standard H-15 highwa loading. Several—of continuous concrete slabs o creosoted pile bents, with an H-20 highway loading—were under construction. During the co struction period, 29 in. of rain had fallen an Seabee demolition crews working with th road gangs had removed land mines and othe explosives totaling 23 tons.

"Engineering accomplishment of this kin performed under the worst possible cond tions," said one of Guam's native contracto "gives me new grasp of an article I recentl read in *Time* magazine. It told about a su vey made by intelligence officers among Ja prisoners to find out what they thought Americans they had met in the field. The had this to say:

"'The enemy understands machinery an is adroit at handling it. Speed characteriz his construction of airfields and motor roads.'

"It seems to me," mused the contracto "That they and Navy Seabees had m before."

Torrential Rains Left Many Sections Under Water

Multiple-Purpose Reservoir Operation of Tennessee River System

Part I. Seasonal Control of Flow

By Clarence E. Blee, M. Am. Soc. C.E.
Chief Engineer, Tennessee Valley Authority, Knoxville, Tenn.

FROM one of the most highly developed river systems in the world comes this record of how a river's flow can be utilized to benefit multiple purposes. On the Tennessee River 26 multiple-purpose reservoirs are operated as a unit, so regulating the flow as to produce a minimum discharge of about 30,000 cu ft per sec where, under natural conditions, the discharge had ranged from 5,000 to 475,000 cu ft per sec. Benefits that accrue are many. Over two million kilowatts of generating capacity are made available. The navigable channel has been extended up river 650 miles to Knoxville. Coordinated operation of flood gates has removed the threat of serious floods. Other benefits tangible and intangible are numberless. In this paper, which is presented in two parts, Mr. Blee tells how the TVA system is operated. The paper has been adapted from an address presented before a joint session of the Hydraulics and Waterways Division at the Annual Meeting.

ONE has but to review a record of the dams and reservoirs constructed throughout the untry during the past decade and examine the list of those proposed r construction in the near future, be impressed by the compara- vely large number of multiple- rpose structures included. An- her noteworthy trend, particularly ith respect to projects having to with flood control, is toward the evelopment of a complete drainage ea by a series of reservoirs. Thus increasing number of engineers e becoming interested in the sub- ct of multiple-purpose operation reservoir systems, not only from e standpoint of operating pro- dure as such, but also from that the effect of such operation on e planning and design of the ructures comprising such a system.

Something of a pioneering effort this field is the system of reser- irs on the Tennessee River and s tributaries, operated by the Tennessee Valley Author- y since 1936 for the multiple purposes of navigation, od control, and power, and now including 26 installa- ons. Having no precedent for the multiple-purpose eration of such a system, the engineers of the Author- y have had to develop methods and techniques to cope ith the situation and to meet the problems which have isen. A discussion of the procedures developed for the eration of the Tennessee River system and of the re- lts obtained may, therefore, be of interest.

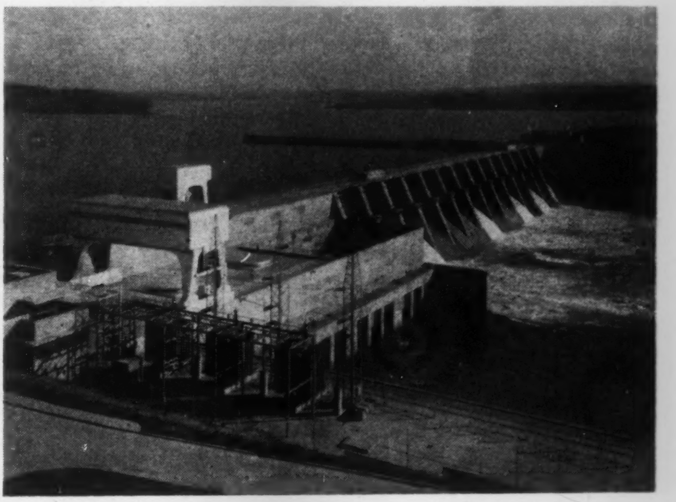
The watershed of the Tennessee River comprises ,000 sq miles, about half of which is covered by forest owth (Fig. 1). The headwaters of the river are in the ountains of eastern Tennessee, of western Virginia and orth Carolina, and of northern Georgia. These moun- ins include the Blue Ridge and Smoky Mountain nges, which rise to an elevation of over 6,500 ft. The ain river begins just above Knoxville, Tenn., at the nfluence of the Holston and French Broad. The rmal elevation of the river surface at Knoxville is out 800 ft above sea level, and at Paducah about 0 ft. Of the 500 ft of drop, some 100 ft are concen- ated at Muscle Shoals, and the remainder are fairly ll distributed over the river, but with the flatter adients below Pickwick Dam (Fig. 2).

Mean annual precipitation for the Tennessee River sin as a whole is approximately 52 in., varying from out 37 in. in dry years to 63 in. in wet years. The ean annual rainfall over limited mountainous areas ar the headwaters may be as high as 85 in., whereas er other areas in sheltered valleys it may be as low s 40 in.

The storms which produce general, valley-wide precipitation and which are potential sources of major floods, are the Gulf storms which enter the Valley from the western end with a generally southwest-northeast storm track. These occur between mid-December and the first of April. West Indian hurricanes, occurring between June 1 and October 15, occasionally strike along the northern part of the easterly boundary of the watershed and move generally in a northeasterly direction. These storms produce intense precipitation over the limited areas traversed.

Snow storage of precipitation does not play an important part in the runoff from the Valley as a whole. Snow occurs to a depth of a few inches in all parts of the Valley and may reach a depth of several feet in the high mountains, but even in the mountains it stays on the ground for comparatively short periods.

As now constructed, the system of dams and reservoirs designed to develop and control the waters of the Tennessee Valley consists of 9 dams on the main river and 12 dams on tributary streams. Under an agreement with the Aluminum Company of America, TVA also directs the operation and water dispatching of that company's five plants on the Little Tennessee River, so that the 26 installations operate as one system. The Tennessee River and its tributaries thus become one of the most highly developed river systems in the world.



Fort Loudoun Dam on the Tennessee—A Typical TVA Main-River Project

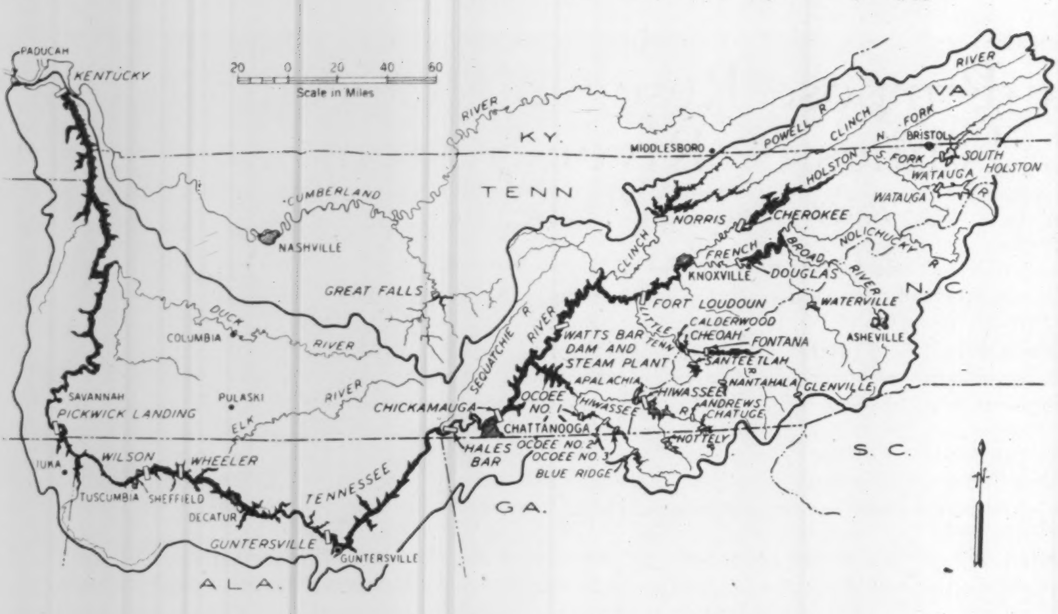

PADUCAH
KENTUCKY
20 0 20 40 60
Scale in Miles
RIVER
KY.
MIDDLESBORO
POWELL R
CLINCH
N. FORK
BRISTOL
RIVER
VA.
S. FORK
SOUTH HOLSTON
WATAUGA
HOLSTON
WATAUGA
CUMBERLAND
TENN
NASHVILLE
NORRIS
CHEROKEE
FRENCH
BROAD
NOLICHUCKY R
KNOXVILLE
DOUGLAS
RIVER
GREAT FALLS
CLINCH
FORT LOUDOUN
WATERVILLE
N. C.
DUCK
COLUMBIA
RIVER
LITTLE TENN
CALDERWOOD
CHEOAH
FONTANA
ASHEVILLE
WATTS BAR DAM AND STEAM PLANT
SEQUATCHIE R
RIVER
SANTEETLAH
NANTAHALA
GLENVILLE
APALACHIA
HIWASSEE
SAVANNAH
PULASKI
RIVER
OCOEE NO 1
HIWASSEE
R
ANDREWS
CHATUGE
PICKWICK LANDING
ELK
CHICKAMAUGA
CHATTANOOGA
NOTTELY
HALES BAR
OCOEE NO 2
OCOEE NO 3
S. C.
IUKA
WILSON
WHEELER
BLUE RIDGE
TUSCUMBIA
SHEFFIELD
TENNESSEE
DECATUR
GA.
GUNTERSVILLE
GUNTERSVILLE
ALA.

FIG. 1. THE TENNESSEE RIVER SYSTEM

The combined gross storage capacity of the reservoirs is 21,000,000 acre-ft, of which 13,000,000 acre-ft are usable within normal operating levels. The continuous length of the slack-water nagivation channel extending from Paducah, Ky., to Knoxville, Tenn., with a navigable depth of 9 ft, is 650 miles. The present total installed hydroelectric generating capacity of the 26 plants amounts to over 2,000,000 kw. In addition, the Authority has available steam-electric generating capacity totaling 450,000 kw, which may be used to supplement the supply from the hydro plants.

Data as to present capacities refer to projects completed or under active construction. Fontana Dam was closed in November 1944; the first unit went into operation in January 1945 and the second unit went into operation in March 1945, completing the installation planned for the present. The fourth and last unit of the Watts Bar Steam Plant started operating in April. The first three units at Kentucky Dam are in operation, and the fourth will go on the line in the fall of 1945. The use of the Kentucky Reservoir for flood-control storage was limited this season, as the reservoir relocation work had not been entirely completed.

In taking up the subject of water control as applied to the operation of this river system, it may be observed that this subject has two phases: (1) long-range or seasonal control, and (2) short-range or day-to-day control.

Long-range control is that which is required to provide the proper reservation of storage space for flood control and to determine the general method of operating for power production to meet the forecast power load. In the case of the provision for flood control storage, a chart or rule curve is prepared for each reservoir showing the limiting elevations above which the reservoir is not to be filled throughout the flood season except in controlling a flood. These limitations are established by the flood-control requirements assigned to the particular reservoir as part of the designed requirements for the whole system.

Normally they would remain constant, except for some change in the basic assumptions or a change from one stage in the development of the system to another. There has been one departure from this procedure, and that concerns certain plants authorized specifically to produce power for wa production. In these cases there was a commitment that such plants would be operated primarily for power as long as the power was necessary for war production. As soon as this power is no longer necessary to meet the requirements of war production, these plants will be placed on multiple-purpose operation under the appropriate rule curves.

In establishing the storage space to be reserved for flood control, recognition is given to the fact that the flood season in the Tennessee Valley is limited to a definite period. Systematic stream-flow records covering the past 70 years, and historical records extending our knowledge to cover a period of more than 100 years, are available. Such records demonstrate that major floods on the Tennessee River are confined to the period between the latter part of December and the first of April. Intense precipitation may be caused in the summer months by West Indian hurricanes striking along the eastern edge of the basin or by local thunder-storms, but neither of these involves sufficient areas to produce a major flood on the main river (Fig. 3).

FLOOD-CONTROL STORAGE ABOVE CHATTANOOGA

The locality in the Tennessee Valley most vulnerable to flood damage is the city of Chattanooga. A repetition of the flood of 1867—the largest flood of record—would, if uncontrolled, submerge the business and industrial district up to a depth of about 20 ft, causing very serious and extensive damage. Therefore above Chattanooga the operation of the reservoir system is directed primarily toward the protection of that city, but it also benefits lands and other communities along the tributaries and main river, as well as on the lower Ohio and Mississippi. The system of reservoirs as now constructed provides over 4,000,000 acre-ft of storage for flood control as of March 15, 1945, in the tributary reservoirs above Chattanooga, as indicated in Table I.

In addition there is a flood storage capacity of some 815,000 acre-ft in the main-river reservoirs above Chattanooga. This, combined with the storage in the tributary reservoirs, affords a total flood-control storage of approximately 4.5 in. of runoff from the entire watershed of 21,000 sq miles above Chattanooga. This storage i

TABLE I. PROPOSED STORAGE FOR FLOOD CONTROL AS OF MARCH 1 IN TRIBUTARY RESERVOIRS ABOVE CHATTANOOGA

PROJECT	DRAINAGE AREA SQ MILES	FLOOD CONTROL CAPACI	
		Acre-Ft	In. of Runo
Norris (Clinch River)	2,912	1,377,000	8.9
Cherokee (Holston River)	3,429	807,000	4.4
Douglas (French Broad River)	4,541	1,020,000	4.2
Fontana* (Little Tenn. River)	1,443	577,000	7.5
Hiwassee† (Hiwassee River)	968	406,000	7.9
		4,187,000	

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* Drainage area excludes that of Nantahala and Glenville reservoirs.
† Includes Nottely and Chatuge reservoirs.

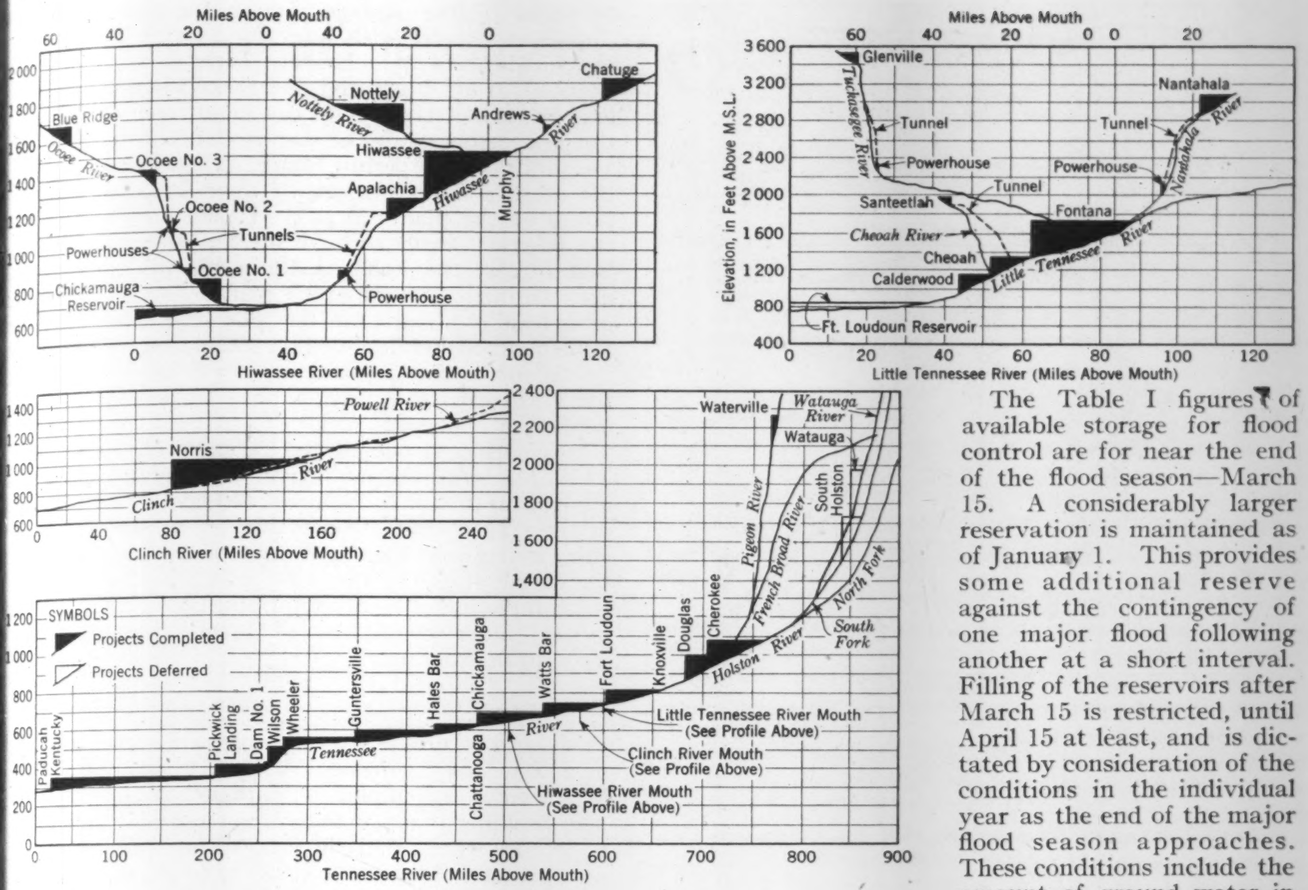
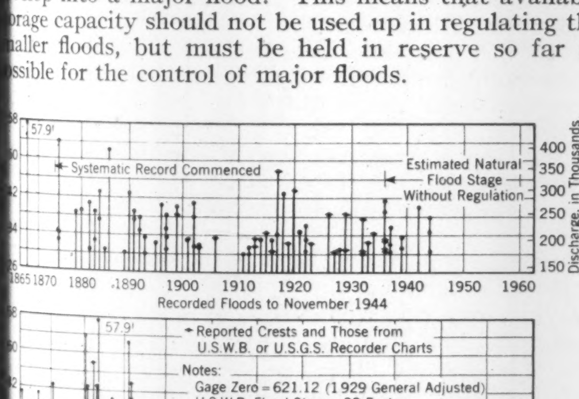

Miles Above Mouth
60
40
20
0
40
20
0
Chatuge
Nottely
Nottely River
Blue Ridge
Andrews
Ocoee River
Ocoee No. 3
Hiwassee
River
Apalachia
Hiwassee
Murphy
Ocoee No. 2
Tunnels
Powerhouses
Ocoee No. 1
Chickamauga Reservoir
Powerhouse
Hiwassee River (Miles Above Mouth)
Glenville
Nantahala
Tuckasegee River
Tunnel
Tunnel
Powerhouse
Powerhouse
Nantahala River
Santeetlah
Tunnel
Fontana
Cheoah River
Cheoah
Calderwood
Little Tennessee River
Ft. Loudoun Reservoir
Elevation, in Feet Above M.S.L.
Little Tennessee River (Miles Above Mouth)
Powell River
Norris
Clinch
River
Clinch River (Miles Above Mouth)
Waterville
Watauga River
Watauga
Pigeon River
French Broad River
South Holston
North Fork
South Fork
Holston River
SYMBOLS
Projects Completed
Projects Deferred
Paducah Kentucky
Pickwick Landing
Dam No. 1
Wilson
Wheeler
Guntersville
Tennessee
Hales Bar
Chickamauga
Chattanooga
Watts Bar
River
Fort Loudoun
Knoxville
Douglas
Cherokee
Little Tennessee River Mouth (See Profile Above)
Clinch River Mouth (See Profile Above)
Hiwassee River Mouth (See Profile Above)
Tennessee River (Miles Above Mouth)

FIG. 2. PROFILE OF THE TENNESSEE RIVER SYSTEM

fficient to control the largest floods of record to such extent as to greatly reduce the damage that would herwise result at Chattanooga. Furthermore, the duction in flood crest resulting from the operation of e reservoirs makes it feasible to protect Chattanooga a system of levees against the occurrence of a probable od considerably larger than the flood of record.

In the use of the reservoir system for flood control, the jective is to regulate the substantial floods only. e science of weather forecasting has made notable vances in recent years but as yet cannot furnish com- tely dependable data as to the duration of a storm. nsequently each flood must be treated as if it might velop into a major flood. This means that available rage capacity should not be used up in regulating the aller floods, but must be held in reserve so far as ssible for the control of major floods.



. 3. DISTRIBUTION OF FLOODS AT CHATTANOOGA, TENN.

The Table I figures of available storage for flood control are for near the end of the flood season—March 15. A considerably larger reservation is maintained as of January 1. This provides some additional reserve against the contingency of one major flood following another at a short interval. Filling of the reservoirs after March 15 is restricted, until April 15 at least, and is dictated by consideration of the conditions in the individual year as the end of the major flood season approaches. These conditions include the amount of ground water in the soil, the progress of the season as indicated by vegetation, and the stream flow and weather conditions prevailing in the last half of March.

Below Chattanooga the reservoirs on the main river have a combined flood-control storage of about 5,000,000 acre-ft, including the 4,000,000 acre-ft behind Kentucky Dam, which is located practically at the mouth of the Tennessee River. This latter storage is in a particularly strategic position for assisting in the control of floods on the lower Ohio River and on the Mississippi River below Cairo. Studies indicate that with the complete system of reservoirs on the Tennessee and its tributaries, the 1937 flood crest on the Mississippi would have been reduced approximately 2 ft at Cairo and that reductions of 2 to $3^1/_2$ ft would have been made in other important floods.

WATER CONTROL FOR POWER PRODUCTION

This discussion of long-range or seasonal control has so far been devoted largely to flood control. The long-range control for hydroelectric power production is something of a complement to the flood-control operations, starting in where the latter leave off. As a guide to reservoir operations, a master guide curve is prepared each year, based on the predicted power load or range of loads for the year. This curve is an envelope of a number of curves, each showing the amount of hydro energy which should have been in storage during certain critical dry years of record in order to carry the designated load with all the steam-electric plants on the TVA system operated to capacity. In general, when the energy actually in storage in the reservoirs is above this curve, no steam or purchased energy is essential; when the stored energy is below the curve, the need of supplying all available supplementary energy is indicated.

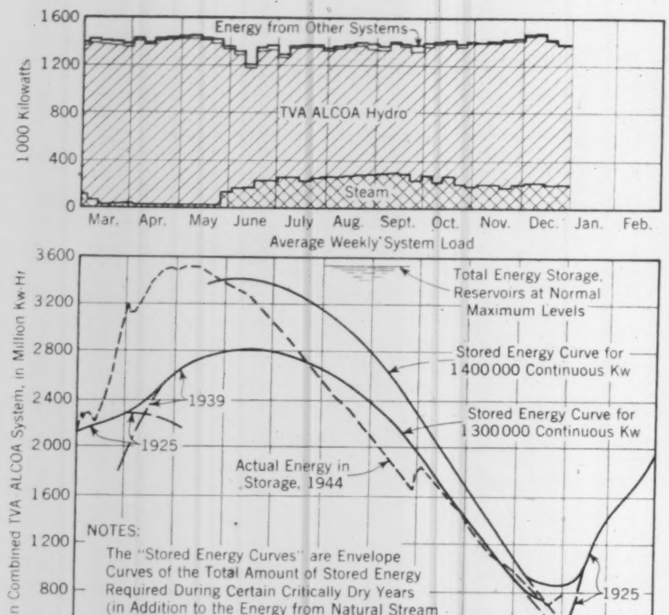


FIG. 4. OPERATING GUIDES FOR 1944 ON COMBINED TVA–ALCOA SYSTEM

This statement, however, oversimplifies the situation. Questions of economy are involved in addition to the ability to carry the load. The supplementary power comes from various sources, with widely varying unit costs. Obviously it is desirable to use the low-cost energy as far as possible, but this means starting its use early, and then it may develop that the corresponding stored energy will be subsequently lost by spilling. The questions of when to start supplementary steam-electric power and how much to use are largely matters of judgment, and the curves are only guides. Factors that must be considered include the probabilities of various patterns of dry years occurring, the extent to which the load might be curtailed or additional supplementary energy obtained in an emergency, and the current runoff and ground-water conditions.

Data as to actual load, energy in storage, and streamflow conditions are plotted on the curve as they develop. This presentation of the data not only gives a good record but also affords a basis for forming judgment as to operating procedures. The master guide curve and operating record for the 1944 season are shown in Fig. 4. It will be noted that during the summer the energy in storage was drawn down considerably below that called for by the guide curve. In this particular case, the decision to avoid the use of the more inefficient steam plants, which would have been required to build up the amount of energy in storage to that called for by the curve, was influenced by the fact that a considerable block of the load was not being furnished as firm power and so could be curtailed. Also it was probable that additional power could be purchased to meet a deficiency if such an emergency should occur.

In addition to the master guide curve, curves are prepared for each reservoir to indicate the desirable distribution of the storage among the reservoirs. The Tennessee River, with sites for storage dams toward the headwaters at relatively high elevations, is well adapted to an integrated operation whereby the power load is carried largely by the main-river plants during the wet season, while the storage dams on the tributaries are shut down to permit filling. Then in the dry season the storage dams are drawn upon heavily, generating power at the plants located at each dam and utilizing the released water through all the downstream plants. Water from the Fontana Reservoir will ultimately be used through a total of 13 plants having a combined gross head of about 1,400 ft. The system had, of course, to be planned and designed for integrated operation, with provision for the requisite installed capacity, and with the necessary transmission lines to accommodate this method of operation.

Navigation is one of the primary objectives of the TVA, but since the main-river dams giving slack-water navigation to Knoxville have been completed, very little in the way of special operating procedure at the reservoirs is required for the benefit of navigation. During the earlier stages of the development and, in fact, until the completion of Kentucky Dam, the operating requirements under conditions of open-channel navigation were quite exacting.

MALARIA CONTROL, AN IMPORTANT FUNCTION

Malaria control is not one of the objectives specifically named in the Tennessee Valley Authority Act, but it has become an important function of the Authority. The building of an extensive system of reservoirs in a region to which malaria is endemic necessarily introduces the problem of controlling the breeding of the malaria-bearing mosquito (*Anopheles quadrimaculatus*) in and along the shores of the lakes. (See "Engineering Aspects of Mosquito Control—TVA," by W. G. Stromquist, CIVIL ENGINEERING for October 1944.) This becomes a problem of reservoir control and must be coordinated with other operating requirements.

In the case of the reservoirs on the main river, the desirable water-level regulation for malaria control is to fill the reservoir to the maximum elevation in the early spring, hold the water at this level for a short period, then drop it to the normal upper operating level. This tends to strand floating debris and to inhibit vegetable growth around the margin of the reservoir. Then, during the mosquito-breeding season (which extends from about May 15 to October 1 in this region), the water levels are subjected to cyclical fluctuations of about a foot at one-week intervals, combined with a gradual water-level recession. Water-level fluctuation is one of the most effective methods of combating the production of mosquitoes, as it strands the eggs and larvae and also draws them out from the protective vegetation, exposing them to their natural enemies. On the large storage reservoirs it is not feasible to fluctuate the water, but the extensive drawdown keeps the edge of the water away from vegetation and on a clean shore.

Supplemental means of mosquito control are also employed, including the application of larvicides by spraying from boats or dusting from airplanes. It has been found that thorough initial clearing, with re-shrubbing of a marginal strip just before impoundment, pays good dividends in reducing the annual cost of larvicidal treatment. In certain localities, it has proved economical to dike and dewater large shallow areas. Again, flat, irregular shore areas have been treated by cut-and-fill excavation to produce a straight, steeply sloping shore.

New Role of Aerial Photography

Combination of Aerial and Ground Surveys Essential for Postwar Highway Planning

By Wilbur H. Simonson, M. Am. Soc. C.E.
Landscape Architect, Public Roads Administration, Washington, D.C.

BEFORE the war, the lack of accurate aerial photographs at scales larger than 500 ft to the inch limited the use of the aerial photographic method to general area maps and general-purpose photographs. Wartime experience, by making possible accurate contour mapping at larger scales, has marked a turning point in aerial photographic surveying—making it useful, and economical, in the location and design stages of highway and related work. The question then arises, "How can we use the various map scales to the best advantage in such work?" Mr. Simonson answers this question and discusses the combination of aerial and ground surveys in a complete operation. This paper was presented before the Surveying and Mapping Division at the Society's Annual Meeting in New York.

THREE-dimensional aerial reconnaissance in wartime strategy focuses our attention aerial photographic surveys and ntour maps, and their use in acetime plans. But how can we t use aerial survey methods in preparation of plans for better hways? How can we re-gear imoded ground survey methods keep pace with faster aerial sury methods? How can aerial otographs and maps make it sier (1) to see the road, roadside, d related land as a single unit of velopment; (2) to work out an proved survey system for better sign; and (3) to save time and oney in the preparation of proj- t plans for large-scale construc- n programs?

The experience of highway de- rtments in combining aerial and ground surveying and pping methods points the way for their more effective e. Systematic use of photographic survey and map thods in every stage of plan preparation will sim- fy the work of administrative and technical staffs gaged in highway and related land development.

FOUR STAGES OF PLAN PREPARATION

Clarity in discussing the use of aerial photographic rveys is gained by dividing highway design into four ges of plan preparation. Table I shows the trend ward the twofold use of photographs and maps in each ge. This table serves also to show how the scale of a otograph or map determines the plan stage in which can be most effectively used.

BLE I. Aerial Photographic Surveys for Highway Plans

Use	Type of Photograph or Map	Graphic Scale Feet to 1 In.	Contour Interval
General area study stage	Uncontrolled mosaic and topographic maps (U.S.G.S.)	2,000 or 1,667	20 ft
Reconnaissance	Overlapping paired prints and controlled mosaics	1,000 or 660	10 ft
Preliminary location	Overlapping paired prints and photogrammetric contour maps	500 400 200	5 ft
Final survey and plans	Enlarged photographs and photogrammetric contour maps	200 100 50	2 ft

If we now think of the four progress stages as paired o two major groups, we find the top pair forming a gh study and reconnaissance group in which qualita- e interpretation of small-scale photographs and maps the primary function, and only general measurements scaling are needed. We find that the bottom pair m a survey-control group in which quantitative asurement is an exacting requirement in map use, and re accurate large-scale photographs and maps are refore essential. Although scales smaller than 500 ft to the inch have proved very useful in the initial study stages, scales larger than 500 ft to the inch have been found necessary in the later plan stages, as Table I shows.

Before the war, only general area maps and general-purpose photographs at scales smaller than 500 ft to the inch were ordinarily available. Highway use of aerial surveys was accordingly limited to the smaller scales of photographs and maps in the general study and reconnaissance stages of the work. But wartime experience with accurate contour mapping at scales larger than 500 ft now marks a turning point in the use of aerial photographic surveys. After the war, therefore, combined use of large-scale contour maps and aerial photographs in the location and design stages of plan preparation will be emphasized.

Table II shows that the scale selected for highway design use is dependent upon (1) character of topography —whether level, rolling, or mountainous; (2) type of land-use—whether open or built-up; and (3) stage of survey—whether preliminary or final plan. All these factors must be considered together when preparing specifications for the making of aerial surveys.

AERIAL PHOTOGRAPHIC SURVEYS

Complete aerial surveys comprise three operations: (1) the taking of the vertical photographs to provide overlapping paired prints; (2) the ground surveys required for photographic control, both horizontal and vertical; and (3) the combining of the photographs and the ground controls to produce either a controlled mosaic, or an accurate topographic map, or both.

As a survey method, aerial photography has three outstanding advantages—speed, economy, and the recording of details in a way that is impossible to obtain by any other method. Table I shows that the evolution of aerial photography in highway use has been through a series of steps—as aerial mosaics, as stereo-paired prints, as photographic enlargements, and finally, as photogrammetric contour maps.

AERIAL PHOTOGRAMMETRIC CONTOUR MAPS

Wartime developments in equipment, materials, and processing now make it possible to prepare complete topographic maps from aerial photographs in one continuous operation. Large-scale precise photography and considerable field surveying for exact control of every photograph are required in making special strip maps with contour intervals sufficiently close for highway use. Such accurate contour maps cannot be made from the average existing aerial photographs which have not been closely tied in with sufficient ground-survey control. The two types of aerial surveys are often confused, but this can easily be avoided by keeping in mind that one type is for small-scale general-purpose maps, and the other for large-scale special-purpose contour maps.

Discussion of these in detail is beyond the scope of this article. For large-scale topography, however, it suffices to point out that the selection of the contour interval controls the entire aerial survey operation. It fixes the flight altitude in relation to the stereo-plotting scale required by the kind of precision instrument used.

TABLE II. MAP SCALES FOR HIGHWAY DESIGN USE

		SURVEY AND PLAN STAGES			
		Preliminary		Final Plans	
CHARACTER OF TOPOGRAPHY	TYPE OF LAND USE	Minimum*	Preferred*	Minimum*	Preferred*
Level to rolling	Open country. . . .	500	400	200	100
	Built-up sections. . .	400	200	100	50
Rolling to hilly	Open country. . . .	400	200	100	50
	Built-up sections. . .	200	100	100	50
Hilly to mountainous	Open country. . . .	200	100	100	50
	Built-up sections. . .	100	50	50	20

* Scales in feet per inch.

The larger map-scales needed to provide 5-ft and 2-ft contour intervals within the specified limits of accuracy can be furnished by precise photographic survey methods in combination with special ground surveys. The art of "spotting" a strategic number of ground control points directly from each of the photographs and marking them on the individual prints for the field survey crews is the key to aerial and ground surveying economy, and to accuracy in topographic mapping. Well-plotted ground-control points, easy of access to field survey crews for measurement of distances and elevations, simplify the correction of prints to a common or uniform scale. The scale-ratio of photographic enlargements can also be accurately controlled by such ground data.

Modern equipment with accurate ratio control makes possible a wide range of conversion from one scale to another. In Table II, for example, a 200-scale base map could be twice enlarged to 100, or four times to 50 if required, or the 200-scale map could be reduced to 400 scale if desired. A graphic scale and base-control grid should be placed on all photographs, maps, and plans selected for enlargement or reduction. Experience has proved the value of a rectangular grid with 5-in. by 5-in. spacing on large-scale maps of 400, 200 and 100 ft to t inch. Such visible control references are an automa check on the accuracy of the converted scale, elimina much confusion and loss of time in the drafting room, a simplify the interchange and transfer of map and p data of different scales to any scale required. Bo graphic-scale and grid controls are shown in Fig. 1.

Aerial photography can be geared to fit the degree accuracy needed in each stage of plan preparation so th design and contract operations may be initiated with minimum of ground-survey work, in three general typ of highway location:

1. In mountainous terrain where ground elevati control is obviously difficult and expensive.

2. In extending mileages where the terrain is une plored and mapping by ground survey methods is sl and time consuming.

3. In arterial highway problems, where the rural urban importance of the improvement, land-use de sity of development, width and value of right-of-wa and cost of construction, require most intensive reco naisance and preliminary study of the whole area befo routes are selected and preliminary location surveys b gun.

Large-scale contour mapping in wartime marks t beginning of a new phase in highway survey and pl preparation. Teamwork of photographer, surveyo draftsman, and designer in streamlining all aerial a ground survey stages will speed up the whole job preparing maps and plans for engineering work af the war. The problem is to select the map scales a survey and plan methods that will best fit a given job.

The use of maps of different scales in the preparati of plans for highway construction and land develo ment is outlined in Table III. Planimetric or topog phic maps at scales of one mile or more to the inch a too indefinite for project-plan use. These are classi as general and schematic groups for outlining int connected systems of transportation, related faciliti and general relief. Such maps are also used as an ind record to show progress stages in long-range constr tion programs in states and regions. But let us co centrate on the use of topographic and photograp maps in the larger scales needed for the preparation plans for particular highway projects.

TABLE III. ANALYSIS OF MAP SCALES FOR AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPS

SCALE TYPE OR GROUP	SCALE RATIO	GRAPHIC SCALE (1 INCH =)	ACCURACY OF SCALED DISTANCES ON PREPARED PLAN PRINTS†	MAP TYPE OR BASIC DATA	MAP USE IN SURVEY AND PLAN STAGES	
General	1:2,344,320	37 miles	Large areas, mileage base	Planimetric or topographic	U.S. & federal-aid highways	
	1:1,000,000	*16 miles	Large areas, metric base		World base map	
	1:500,000	*8 miles	Interregional area, metric		Military strategic map of U.S.	
Schematic	1:250,000	*4 miles	Regional areas, metric base	Planimetric or topographic	State-wide transport map	
	1:125,000	*2 miles	State regions, metric base		Selected state-area enlargement	
	1:62,500	*1 mile	Estimated 96% within 200′		Metric base control map (U.S.G.S.)	
Small	1:31,680	1/2 mile	Estimated 96% within 100′	Topographic	Metropolitan area mileage base maps gen. study of area and type only key-map diagram stage of planning	
	1:24,000	2,000′	Estimated 96 1/2% within 75′	Topographic		
	1:20,000	1,667′	Estimated 97% within 50′	Topographic or photographic		
ntermediate	1:12,000	1,000′	Estimated 97 1/2% within 25	Topo-photo.	Alternate route-study stage	Accurately ratioed photographic scale enlargements for progress studies
	1:10,000	833′	Estimated 97 1/2% within 20′	Topo-photo.		
	1:8,000	666′	Estimated 97 1/2% within 16′	Topo-photo.		
Medium	1:6,000	500′	Estimated 98% within 10′	Topo-photo.	Overall control plan stage	
	1:4,800	400′	Estimated 98% within 8′	Topo-photo.		
	1:2,400	200′	Estimated 98% within 4′†	Topo-photo.		
Large	1:1,200	100′	Estimated 98 1/2% within 1.5′	Base plan (1″ = 100′)	Final survey and contract plan stage	
	1:600	50′	Estimated 98 1/2% within 0.75′	Detail plan (2.0 × base plan)		
	1:480	40′	Estimated 98 1/2% within 0.6′	Detail plan (2.5 × base plan)		
Special	1:240	20′	Estimated 98 1/2% within 0.3′	Special details and plans for graphic accuracy and simplified procedure (5.0 × base-plan scale)		

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* Approximate.

† Example of limitations in scaling, including errors in transfer of base-map data to 1 in. = 200-ft scale plan; 100% − 98% = 2% × 200 ft = 4 ft oIrdinate control assumed for correction and compensation of scaled distances).

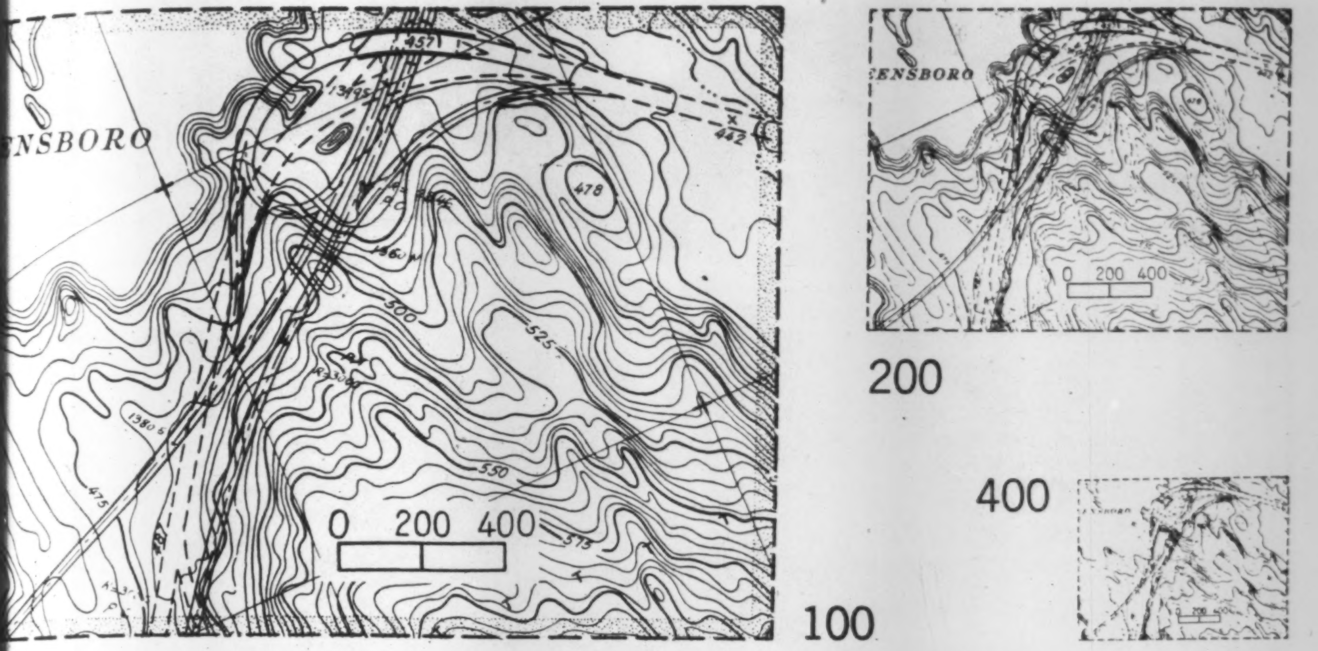


FIG. 1. COMPARISON OF MAP SCALES, IN FEET TO THE INCH

Table III gives a step-by-step breakdown of the whole ge of working scales for highway use and shows how a nplete series of scales can be grouped for ready conrsion by photographic enlargement or reduction as ired. Take, for example, a single original aerial vey as made by the Agricultural Adjustment Agency h contact prints at a scale of 1,667 ft to the inch. largement about $2^1/_2$ times to 660 ft to the inch (8 in. the mile) makes the scale of the photograph useful for study of alternate routes (reconnaissance stage). the original negative might be enlarged slightly re than four times to obtain the larger scale of 400 ft the inch suitable for preliminary location and design . Under ideal conditions, with clear negatives, selected tions of the small, 1,667-ft photograph have been arged over 8 times to provide an even better workscale of 200 ft to the inch. Base-control topographic ps or map sheets can be similarly converted to the rking scales desired. A range of flexibility is proled in each of the basic scale-groups to fit available otographic and topographic maps where necessary. r dependable accuracy of control, however, enlargents are usually held within two to three times the ginal source-map data.

I. *General Area Study Stage.* Aerial mosaics and pographic maps of small scale are useful for general nning purposes where only area and type of work d be outlined, and scaled distances within about 100 are considered sufficiently close to show the problem skeleton or diagram form.

II. *Reconnaissance Stage.* Overlapping stereo-paired nts and controlled mosaics of intermediate scales ging between 500 and 1,000 ft to the inch are of value making preliminary reconnaissance studies of large as. Such photographic surveys are economical and isfactory for general study and comparison of altere highway routes where scaled distances within 25 or about the width of a two-lane pavement, are sufently close for making a route selection in advance of liminary location and design plans.

III. *Preliminary Location and Design Stage.* Overping stereo-paired prints and contour maps larger n 500 ft to the inch are ideal for preliminary highway location and overall control use where scaled distances within the close limits of 10 ft, or less than the width of one traffic lane, are required in the design computations.

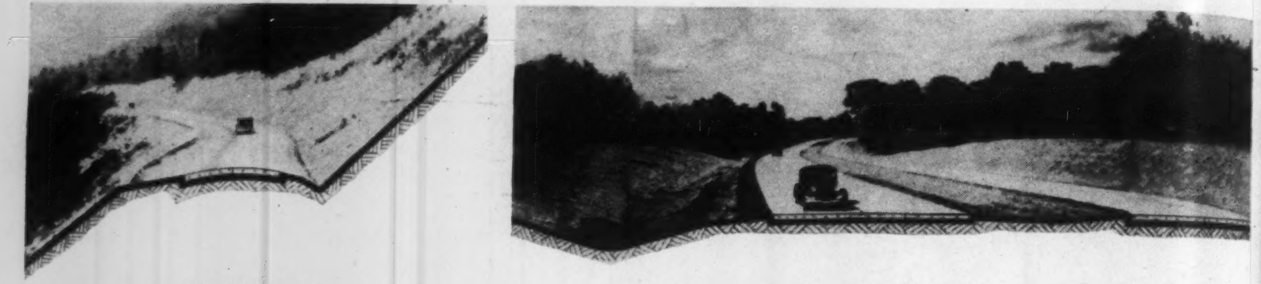
IV. *Final Survey and Plan Stage.* Enlarged photographs and contour maps at a standard plan scale of 100 ft to the inch, and larger, are useful in highway work where scaling of distances to the nearest foot or two is within sufficiently close limits for the practical needs of field construction. Photographic prints may be furnished to the designing engineers in advance so that rough studies may proceed without waiting for completion of the topographic maps. Construction work can be promptly initiated with a minimum of ground surveys.

Large-scale maps and plans, as suggested in Table II, are commonly used for the working plans, specifications, and estimates for grading, drainage, planting, and other construction and development work.

Where final location surveys and working plans require detail ground accuracy closer than obtainable graphically by scaled distances, the usual ground-survey procedure will be used as necessary to complete the contract plans. Material reduction in ground-survey work and computations in the early stages of reconnaisance and in the preliminary location and design stages of highway work by means of photographic processes saves a great deal of time. This of course speeds the final surveys and plans.

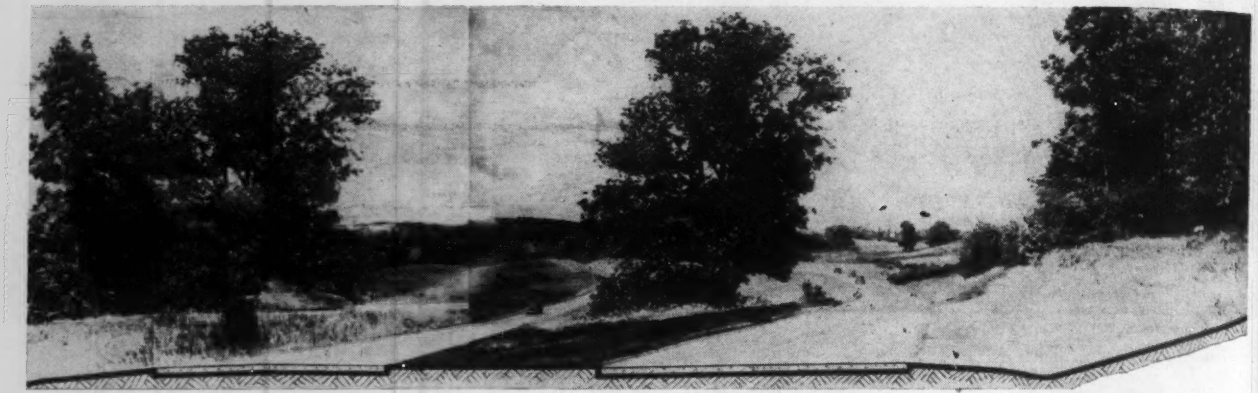
AERIAL AND GROUND SURVEYS INTERDEPENDENT

A reasonably uniform and economical scale-system as here outlined seems to be needed to bring all types of surveys and maps into closer relation. Aerial surveys need not be in competition with, nor tend to displace, essential ground surveys. On the contrary, air and ground surveys are complementary to each other. Combined aerial and ground survey methods should result in more surveys, and more complete surveys, than ever. Detailed surveys of special development areas, as at bridges, grade separations, or parking layouts; final staking of locations for construction; the running of accurate base-line controls; precise surveys of property and right-of-way lines; and the measurement of con-



World War I

Pre-World War II



Contemplated for Postwar Period

FIG. 2. NEW AND OLD IN HIGHWAY STANDARDS

struction quantities, will all tend to be done on the ground. Each survey method has a place and should be used to the best advantage for the job to be done. Continued improvement in equipment, materials, and methods has narrowed the one-time gap in accuracy between aerial and ground surveys. There is now no question of the advantages of large-scale aerial photographic surveys in combination with the old reliable ground methods.

MAP-MAKING AND MAP-USING

A high degree of survey and map standards will only be attained when the individual scales are made generally uniform by map-making, map-servicing, and map-using groups. All must be in mesh. The reader should keep in mind the distinction between map-making and map-using. In this discussion, the use of reliable maps based on accurate horizontal and vertical ground survey controls is assumed. The relative accuracy of distances scaled from photo-enlargements, or other map sources, is of course dependent upon the initial accuracy of the control map used. Here we assume that the construction plans will be prepared from a coordinate control map so that the accuracy of scaled distances taken from prints in the field will safely fall within the percentage limits indicated for the respective working scales. The estimated accuracy of scaled distances is based on the assumption that maps made with the precision of typical aerial photogrammetric methods are equivalent to usual hand-drafted maps and meet War Department specifications and National Standard Map Accuracy requirements.

Since the use of a map determines the scale that should be selected, and the scale is dependent upon the relative degree of accuracy required of scaled distances on prepared prints, the use of a map should govern its making, and not the reverse—as too often happens—that map-making should unnecessarily limit the use. Since map accuracy and map cost are so closely related, sound engineering judgment needs to be exercised in the degree of accuracy required by the progress stage of the wor Table III may be helpful as a guide in selecting ma scales appropriate for highway use.

Figure 2 pictures highways several times the width those in use twenty-five years ago. Obviously, postw highway building requires more than the simple base-li surveys made for the roads of 1920. Dependable, u to-the-minute surveys over a broad band of terrain a vital to a sound highway program after the war. Top graphic highway controls, traffic survey data, land-u studies, and evaluation of existing and contemplated i provements must all be weighed to a nicety of balanc Plan preparation for tomorrow's wide streamlined hig ways can be facilitated and made more effective by t twofold use of aerial photographs for stereoscopic stu and large-scale topographic maps for preliminary loc tion and design. The designer, with the draftsma the photographer, and the surveyor—these technicia teamed together—form a new nucleus for making t most of modern machine methods to obtain comple survey and map information needed for postwar hig way and related land development.

The Federal-Aid Highway Act of 1944, in extendi federal-aid to cities for arterial highways and to counti for feeder roads, places new responsibilities on hig way administrators. It is important to note also th $100,000,000 is now authorized, and when appropriate can be made immediately available for the "maki of surveys and plans."

Building better integrated state systems of state, ci and county roads into a more complete national highw system will require all authorities and technicians work closely together. Systematic use of both aer and ground surveys in every stage of highway work w save time in supplying public officials and administrato with the surveying and mapping facts needed to ma initial decisions in highway location and design, and put working plans into the blueprint stage in readine for postwar programs.

Engineers' Odyssey to Europe—1889

V. Return by Varied Routes

By A. Prescott Folwell, James B. French, Andrew J. Provost, Jr., *and* T. Kennard Thomson
Members Am. Soc. C.E.

THE last official gathering of the American engineering group visiting Europe in 1889 was in Paris. Up to that point the English and French entertainment had been for the party as a whole. By contrast the return to America, as detailed here, was generally made in individual groups. Experiences correspondingly were more varied, from Black Forest inns and Alpine hospices to German laboratories, from a Rotterdam bank to the Forth Bridge Construction. In this last paper of the series, our four historians write appreciatively of scenery, travel, and food. Not the least satisfying part of these trips in retrospect was the realization that they had been made with really remarkable economy.

FRENCH: After spending a week in Paris with the party of American engineers, I took an ening train for Geneva, Switzer-nd, in company with Julius Baier, fellow Junior of the Society, from . Louis, of about my age and of milar interests.

Provost: The affair with the lice so dissipated the allure of ris that Folwell and I immedi-ely took a night train to Switzer-nd. Before reaching Martigny, e glimpsed a very high and spec-cular waterfall, which cascades ar the railroad. We were seated the wrong side of the car to get snapshot, so Folwell made a dive ith the camera to the other side, here were seated a young Swiss couple having every ap-arance of being just married. A lurch of the train de-sited Folwell in the girl's lap. She didn't seem to mind t the groom was glum. We got no picture.

Several weeks spent in Lausanne in after years proved e city to be most interesting, but my chief recollection my first visit is of a dish served for dessert—a large uit dish filled with field strawberries accompanied by pitcher of thick, sweet cream.

SAMPLING FAMOUS HOSPITALITY AT MT. ST. BERNARD

French: Mr. Baier had a letter to a gentleman in erne, with whose brother he had been working in St. ouis, and in him we found a very pleasant guide. nowing we were engineers, he took us to see a fine idge over the Aar, then to the Bear Pits filled with liv-g representatives of Berne's emblem, then through ar-ded streets similar to the Rows of Chester in England, d to the old clock tower, which we reached just in time see the procession of Knights, hear the crowing of the oster, and observe other contrivances.

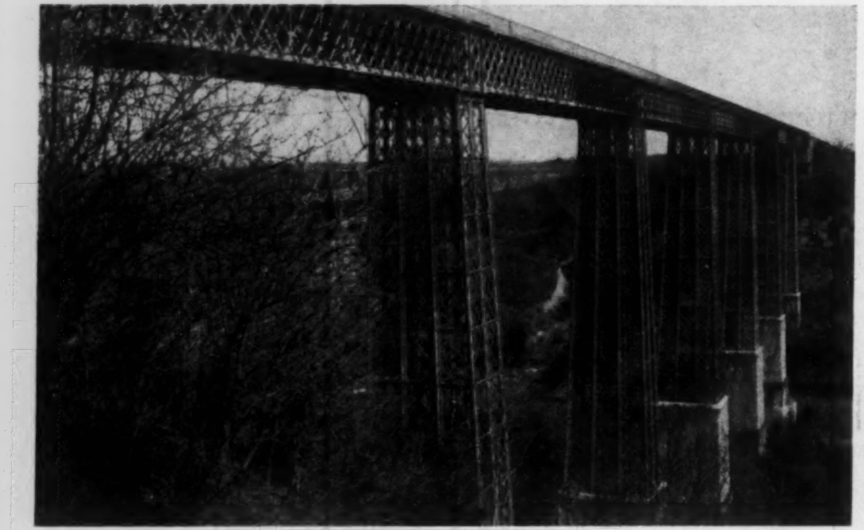
Provost: We got an early start e morning and, taking with us in all haversacks only the essentials r an overnight trip, we set out for hamonix, thirty-five miles or so dis-nt. It was the 14th of July, and early it was, small groups of Swiss were sembling to celebrate the Fall of the astille and the heroism of the Swiss uard. We had a general map of the gion, but the highway was so good, d our spirits so high, that we gave little attention. At noon we found e were at Orsièrres, far beyond the ail leading to Chamonix. We learned at the route straight ahead was the ilitary highway built by Napoleon r the transitof his armies and sup-ies to Italy, also that it would take to Mt. St. Bernard and its celebrated spice, so we decided to go there.

Before dusk, we arrived at an inn near the foot of the trail leading up to the Hospice. The inn-keeper strongly urged us to stop overnight and make the ascent on donkeys in the morning. However, we could see the outlines of the Hospice high above us; there was still some light and the promise of a good moon, so we decided to move on. The trail was merely a mule path and far from straight. Until we had accomplished about one-half of the five-mile climb, lights shone from the Hospice windows. Then these disappeared and heavy snow began to fall.

We had been above the snow line for some time, and had thought it quite a lark to be able to snowball each other in mid-July. Dressed as we were for summer weather—in low shoes, light underwear, and without vests—we became bitterly cold. The trail became covered and we often lost it completely. Except for a small flask of brandy that, fortunately, I had put in my haversack, the situation might have been serious. We were able to stagger on until near enough to make ourselves heard, when some monks and dogs came to lead us to welcome warmth and shelter. Although the evening was far spent, the monks hastened to prepare us a fine dinner, and plied us generously with wine.

From our bedroom windows we could see the nearby tarn, or small lake, that is never without its surface of ice and snow. The storm was over, and a full moon lighted up a wonderful scene. We were some 9,000 feet above sea level. Our beds were provided with a generous number of feather mattresses, and beneath several of these we were most comfortable. Before falling asleep, we heard the brothers chanting as they descended the stone staircase to the chapel for midnight mass.

On the Trail to Chamonix, Scene of an Interesting Alpine Adventure



RAILROAD VIADUCT, FRIBOURG
Engineering Structures Received a Generous Share of Attention

In the morning, our hosts gave us an excellent breakfast and then a God's-speed for the 35-mile return trip. There was no charge for our entertainment, but an alms box in the Chapel permitted us to express our gratitude. During the return trip we met our bride and groom of the train incident on their way to the Hospice. The young lady, who was riding a donkey, gave a smile of recognition. From the groom there was only a scowl.

IMPRESSIVE SCENERY AND TRAVEL ADVENTURES IN SWITZERLAND

FRENCH: We joined two Austrian fellow travelers in hiring a two-horse open carriage and driving to Lauterbrunnen, a small hamlet at the foot of the mountains, from which we climbed on foot to Mürren, a distance of 4 miles by bridle path and about 2,700 ft higher than Lauterbrunnen.

Just before we reached Mürren, the path emerged from the woods on to a comparatively flat greensward, on which a little Alpine village was located. There was spread out before us an amphitheater of snow-covered mountains, among them the peak of the Jungfrau which we had seen from Interlaken the evening before. There was not a cloud to mar the view, and I remember it as the finest mountain panorama of the trip. Our Austrian companions were particularly enthusiastic.

PROVOST: For climbing Mt. Rigi a funicular railway was provided that took indolent travelers to the top in a matter of minutes. This was an interesting device consisting of two cars having sloping seats, connected together by a cable the length of the incline. The car at the summit had its tanks sufficiently filled with water to enable it to drag the other car to the top. When the upper car descended to the lake, its load of water was wasted.

FRENCH: The approach to the tunnel up the Reuss Valley in Italian Switzerland, with its long ascending loops and spiral tunnels, impressed us as the most wonderful stretch of railroad location we had ever seen.

PROVOST: We had with us a copy of Mark Twain's *Tramp Abroad*, a humorous guidebook of the region. Finding that Twain and his friend took a tramp through the Black Forest, we decided to do likewise. Taking with us only the barest necessities, and shipping the heavy baggage ahead by rail, we entered the forest just north of Strasbourg.

FOLWELL: We enjoyed one experienc that no tourist party would have had. Fro mid-afternoon we had been looking for lodging for the night but had not seen single inn or other building. Darkness ha fallen when, topping a rise in the road, w saw in the valley ahead a few scattere lights. Hastening toward these, we wer astonished, when halfway down the hill, t see them all disappear almost simultaneously. Arrived at the road intersectio where we had seen them, we groped throug the dark past four or five buildings an dimly discerned a sign-board projectin from one of them. Assuming that thi must be an inn, we rapped on the door which was opened by the landlord. He invited us into a room which was in total darkness until he lit a candle, the light of whic revealed several men seated around a table drinking.

PROVOST: None of these peasants ha ever been as far away as Strasbourg They had heard of the famous clock i the cathedral there and were most anxious for us t verify, as we were able to do, that it boasted a lio who roared out the hours, followed by a procession of th twelve apostles who appeared at one doorway and exite at another. We were given something to eat; occupie the only bedroom (forcing the proprietor, his wife, an child to sleep in the stable with the animals); and ha breakfast.

FOLWELL: We were brought the visitors' book an asked to register in it. This book interested us greatly The registrations went back more than ten years but di not exceed in number about a hundred, and did not contain a single English name, although there were a fe Japanese. After breakfast the next morning we wer presented with a bill for about $1.00 for two meals eac and lodging.

INVESTIGATING GERMAN BYWAYS AND UNIVERSITIES

PROVOST: Constant rain dogged our steps the following day. It would have been possible to reach Baden-Baden before nightfall, but our attire was in such disreputable condition we doubted whether the fashionab resort would welcome us. Just short of that destinatio we reached a hut and obtained a room destitute of furniture except for a bed. Sending our clothing to be dried we each wrote a letter home sprawled on the bed an using the wall for a desk.

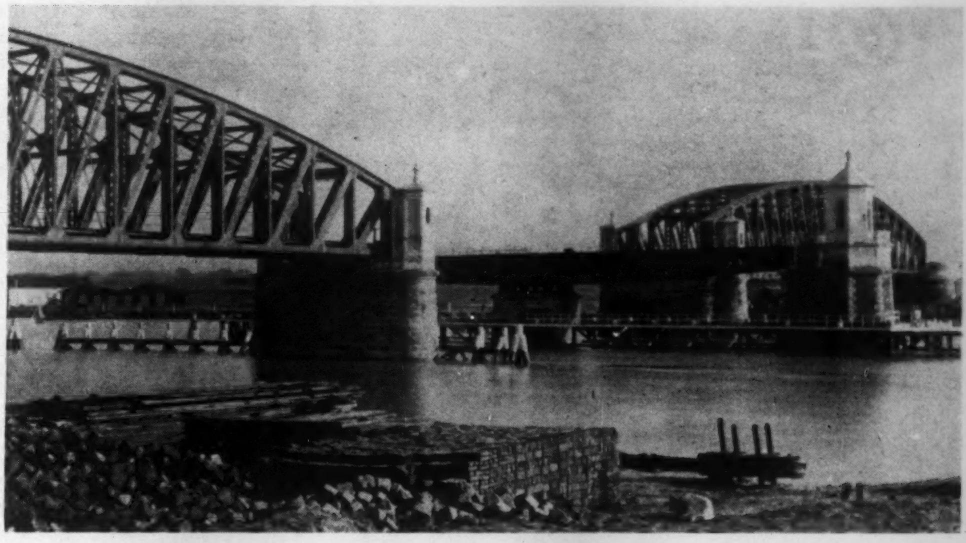
Dry again, but with clothing out of shape, we walke into Baden-Baden early on a beautiful morning. It many fine hotels looked hospitable from the outsid but the clerks shook their heads at sight of us. Gettin the ear of the proprietor of a really de luxe establishmen we secured a room, reclaimed our heavy baggage, an were able to make ourselves presentable. At lunch, th proprietor, who spoke English, came to extend a renew greeting. He opened a bottle of his oldest wine, loane us his coachman and team for the entire afternoon, an entertained us in the evening at the opera, where a Ge man cast presented *The Mikado*. No charge was mad for any of these favors.

FRENCH: I had made an appointment to join Profess Crandall and his party. One of his purposes was t learn what was being done in European engineerin schools in developing facilities for testing materials construction. He therefore made visits to the technic schools in Zurich, Munich, Stuttgart and Carlsruhe,

hich I was privileged to ac-
mpany him. He was pro-
ded with letters of introduc-
n to the professors in charge
such work and was able to
t a comprehensive view of its
atus, which was, briefly, that
each of the schools visited
rk in this field was being
rried on by an individual pro-
ssor with the assistance only
some of his best students.
o general courses such as
re later developed in Ameri-
n schools were then given at
y of the schools visited.

Folwell: Several of the
otographs taken by me in
rope fail to more than sug-
st their subject. Most re-
etted among these is one
at looks like a small Ferris
heel. It was really a labor-
ilizing device seen in Belgium.
e wheel was about 30 ft in
ameter and was constructed like a squirrel cage about 5 ft
ng. Three men substituted for the squirrels and walked
the inside ladder-like periphery of the wheel, causing it
revolve. Outside the wheel, on the same shaft, was a
um about 3 ft in diameter, on which was wound a rope
hich, passing through a loftily suspended pulley, raised
ilding stones to position on the structure being built.
suming that the three men together weighed 500 lb,
d allowing 20% loss in friction, they could lift about
00 lb at a speed of perhaps 20 ft a minute.

Thomson: When starting the all-day trip from Paris
Brussels, I tipped the railway guard, who promised
t to let anyone else in our compartment. But at
ery stop a fresh guard or porter wanted another tip.
his "got my goat," so as we neared each station I pulled
e blinds down and put the handle of my umbrella in
e handle of the door so that the door could not be
ened from the outside—in spite of many attempts.
rtunately for us, the railway men took it as a great
ke, thinking that we were a runaway couple.



Large Bridge at Rotterdam
Both Engineering and Finance Engaged the Visitors at This Famous Dutch City

HIGH FINANCE IN HOLLAND

Folwell: Speaking of finances, we had what must
ve been a unique experience—we cheated a bank out
$90. Almost out of cash in Rotterdam during our
e day in Holland, and expecting to reach England the
xt day, we asked the bank to furnish us with two
unds on our letter of credit. The cashier counted
pper, brass, and silver coins into a brass shovel and
nded them to me, with some paper money—all of
hich I put uncounted into a coat pocket. It seemed
e a lot for $10, but neither of us knew anything about
e exchange value of Holland money. Sitting on the
nk's steps, we divided each kind of coin into two equal
rts, as was our practice, and each pocketed a half.
ter we learned that we had actually received the
uivalent of twenty pounds. By that time, however,
e bank had closed.

Provost: No one was able to give us the address of
y of the bank's officers, and our steamer was to sail
most immediately. Inquiries made thereafter at the
fices of our bankers in London, Liverpool, and New
rk failed to throw any light upon what anxieties the
nk at Rotterdam might be undergoing. Eventually
e bank wrote me personally, stating it had made an
er-payment to some one on the stated day and asking if by chance it might have been I. As the result of further correspondence, the bank suggested restitution in American dollars plus the exchange rate, and plus interest. While this looked like a Shylock touch, we willingly complied, since the error had supplied us with needed funds for our last days in England.

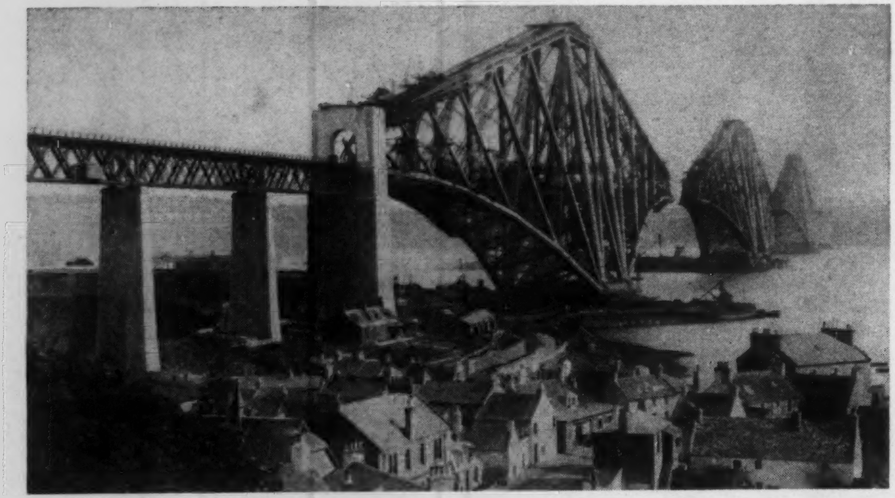
Thomson: In those days tipping in Europe was far more prevalent than in the United States or Canada—but fortunately both in England and on the Continent it was generally in copper coins—so I kept a pocketful of pennies or their equivalents.

On the Continent we stayed at hotels, and on our arrival at each hotel we were greeted by the courteous manager, or whatever he was called, and each time we had to bargain for accommodations. We always had to be careful to insist that the amount was "tout complet," that is, no extras. When leaving we had to tip everybody—especially and in much larger amounts, the managers, as they were paid no salaries and in some cases probably had to pay the hotel for the privilege of running it. As in England, we were given, and charged for, two candles a day. What we missed most on the Continent was drinking water.

PRIVILEGE OF INSPECTING FORTH BRIDGE UNDER CONSTRUCTION

French: Later I again joined Professor Crandall on a trip to Scotland and an inspection of the Firth of Forth Bridge. We were given every opportunity to make as thorough an inspection as our time allowed. At that time (August 1889) the three large towers, each with its two projecting cantilever arms, had been erected and the two intermediate suspended spans were in process of erection. We were lifted from the foundation to the top of one of the towers and were able to walk on a plank footwalk with a substantial handrail on the top chord of one of the cantilever arms down to its junction with the suspended span. Then we were dropped by a wire rope to a material barge floating in the water. This procedure gave us an excellent opportunity to see the completed work—not only to take in its magnitude as a whole, but to realize the enormous size of its main compression members, the largest of which were boiler-like cylinders 12 ft in diameter.

Familiar as we both were with American methods of fabrication and erection of steelwork for bridges, we were



FORTH BRIDGE UNDER CONSTRUCTION
Inspection of This Work, One of the Outstanding Projects in Bridge History, Was a Highlight of the European Trip

particularly interested to learn that no prefabricated members had been shipped to the site but that independent shops had been set up, and special equipment had been built there to perform all the work involved. This equipment included machines for bending the plates, planing their edges, and drilling connection holes. Hydraulic riveters were carried in specially designed cages for riveting the plates together in their final position. We were also told that panel or control points, where the axes of different members came to a common intersection, were fixed in the field by theodolites and steel tapes as the work progressed.

THOMSON: On our return from Paris to London I thought that we should visit the Portsmouth Navy Yard. But when I registered as an United States Citizen from Philadelphia, the officers said that I could not enter without a pass, which I could only obtain in London.

But my wife said that she was a Canadian and that they could not keep her out—so the officers very kindly showed her over the whole place, taking two hours. Meanwhile I kicked my heels in the dusty road—and it was hot. My wife said that she did not think that she had been gone very long, and that they were very polite to her. It struck me as a joke, because if I had wanted any information for improper use, my wife could have told me all that I could have seen if I had been with her.

FOLWELL: Partly because of enforced economy, I walked from Manchester to Liverpool along the ship canal, then under construction. An interesting feature was that the entire length of the canal was enclosed with a high board fence on each side. Admission inside required possession of a pass, obtained at the chief engineer's office in Manchester. There was no advertising on this fence—certainly a loss of considerable possible income.

In contrast, about the same time in America a contractor named More, who was constructing a deep sewer through the center of one of the main business streets of Buffalo, N.Y., and had erected (by contract requirement, I believe) a high board fence along each side for the entire length, received enough from advertising rights on these fences to much more than pay for them. (Incidentally, this was, as I recall, the first job on which the More trench machine was used.)

THOMSON: We saw everything that we could in that beautiful and interesting city of Edinburgh. There, in London, and elsewhere, we were surprised to note the extreme poverty of the lower classes— nothing like it in America.

We visited one of the great shi yards on the Clyde. The compan had one of their draftsmen show around the yard—taking a couple hours. We had been tipping everyon but were in a quandary as to whethe the draftsmen would resent a tip (an American would). But he seeme glad to take half a crown (about 6 cents).

At Aberdeen we saw women salt ing and barreling Scotch herrings— the world was not as hygienic then a it is now. As a boy in Canada an the son of a Scot, I had eaten man herrings, and much porridge—but have scarcely ever eaten a scotc herring since our trip to Aberdeen.

FOLWELL: This may be an appro priate point to tell the cost of the tri The steamship fare to Liverpool an return, first class, was $125. Provost and I had a joi letter of credit for $500, and on this $250 each we travele to London, Paris, most of Switzerland's tourist citie many cities in the Rhine valley, Brussels, Rotterdam, an across the North Sea and England to Liverpool. The un expected $45 each acquired in Holland we spent for no essentials. Provost bought a suit of clothes in Londo and I forget where mine went, but it all went—and the some. In fact, I was compelled to strict economy durin the last three or four days in England and landed in Ne York with just 25 cents in my pocket.

PROVOST: While we practiced convenient econom this did not preclude some indulgence in things w wanted to see and do. It is altogether probable that ou per diem expenditure, about $4.50 per capita for 90 day fairly represented the average for the entire party. Th was only slightly in excess of the estimated cost an nounced in the prospectus.

THOMSON: By watching our step we lived well an enjoyed ourselves, and I think that the total expens for my wife and myself from the time we left New Yo until we returned four months later was about $1,20

FRENCH: It may be of interest to add that my enti expense chargeable to this memorable three month trip was less than $500.

REUNION DINNER IN NEW YORK

PROVOST: Our arrival in New York was fortunate so timed that we were able to attend a reunion dinner about fifty of the trip party who could be got togethe This was tendered by some engineers who had bee unable to make the trip, and took place at the Enginee Club, then located at 374 Fifth Avenue, the former res dence of J. Coleman Drayton. Some of the officers the SS *City of New York* were present. Of the man speeches made, I recall best that of the chief engineer the ship, who ventured the opinion that the limit of com bined speed and size of ships for tourist service had bee substantially reached. This statement was undispute No one present could visualize that turbine engines an liquid fuel were destined to shatter the theory. Th *Queen Mary* and the *Normandie* were as remote in th technical conception of that day as the airplane and th automobile.

THOMSON: We have always been thankful that w took that trip and enjoyed it when we had the chance— and for the friends we then made and retained.

Overall Plan for Grand and Verdigris Rivers

Dual-Purpose Reservoirs to Serve Area in Kansas and Oklahoma

By W. C. Burnham, M. Am. Soc. C.E.

Hydraulic Engineer, Southwestern Power Administration, U.S. Department of the Interior Tulsa, Okla.

DRAINING an area of 20,810 sq miles above their junction with the Arkansas River at Muskogee, Okla., the Grand and Verdigris rivers have brought down periodic devastating floods. To date considerable planning has gone forward to create a number of multiple-purpose projects on these two river systems. Nine reservoirs are at present considered essential to the plan. One dam, mile-long Pensacola, was completed in 1940. A second, Fort Gibson, has been started, but work has been suspended during the war. Plans and surveys are complete for a third structure at Markham Ferry Dam Site. The paper from which this article has been prepared was presented before the Oklahoma Section.

INCREASINGLY attention has been given to the problem of control of the water resources of tire watersheds as opposed to the anning and construction of isoted storage or protection strucres. As an example of a program hich considers the needs of a whole atershed (in fact two adjacent atersheds), the study of the Grand d Verdigris rivers is interesting. ere are combined problems in flood ntrol, irrigation, power generaon, and navigation. Cooperating the study are the Southwestern ower Administration, U.S. Corps of ngineers, Grand River Dam Auhority, U.S. Geological Survey, oard of Water Resources of Oklaoma, and Arkansas State Board of Water Resources.

The watersheds of the Grand and Verdigris rivers cover bout 20,810 sq miles of Kansas and Oklahoma, overpping into the states of Missouri and Arkansas. As an be seen in Fig. 1, these rivers empty into the Arkansas vo miles apart near Muskogee, Okla. The flash floods escending from the two rivers at their junction with he Arkansas have often caused extensive damage in Iuskogee and surrounding territory.

Two great floods occurred within a period of 10 days in Iay 1943. They were caused by two separate and istinct storms—an unusual occurrence. The new ecords established by these storms are now the criterion f reservoir design in the area. The U.S. Corps of Engieers estimated the crest discharge on the Grand River r the maximum probable storm of Pensacola Dam to be 50,000 cu ft per sec. The maximum flow into the eservoir was very close to this amount. The U.S. eologic Survey's engineers estimated the crest flow at Iarkham Ferry to be 400,000 cu ft per sec, and the ame at the Wagoner gage, which is a short distance bove the Fort Gibson dam site.

The records and estimates of the May floods are uch better than for any previous storm flows. These ata indicate flood storage necessary to reduce the aximum probable storm flow to a minor flood.

On the Grand River, the Wagoner gage measures the torage required above the Fort Gibson Dam site. According to this gage, the total flood flow during the eriod from May 9 to May 29 reached 5,600,000 acre-ft. o reduce the average discharge to the river's capacity f 100,000 cu ft per sec, storage of some 1,600,000 acre-ft ould be required.

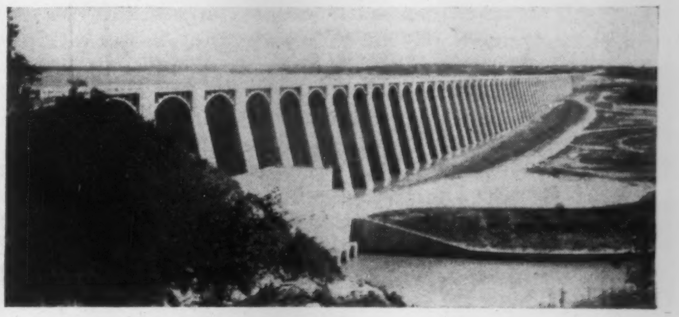
The flood storage already provided in Pensacola Reseroir is 540,000 acre-ft. The Markham Ferry Reservoir ill store an additional 233,000 acre-ft, and the design f the Fort Gibson Dam contemplates a flood storage of 22,000 acre-ft. The total of 1,695,000 acre-ft will herefore provide adequate control of any flood of record.

The May flood brought out an interesting arrangement or storage in the Pensacola Reservoir. The top of the ower pool is at El. 745. Five feet of flood storage—to 750—had been purchased by the Grand River Dam Authority. At the time of the flood, the Federal Government was in the process of obtaining rights for an additional 5 ft—to El. 755. All easements had not been obtained. During the flood water was stored to 754.58 on land not yet owned by the government. Therefore many damage claims resulted. Nearly all these rights have now been obtained.

All the Verdigris River basin was included in the May 1943 storm area. Here, too, the completeness of the records kept aids in determining the needed storage. If the discharge at Claremore, Okla., were reduced to a maximum of 30,000 cu ft per sec, a total of 2,100,000 acre-ft of reservoir capacity would be required. This storage on the Verdigris River can be operated for the benefit of the Verdigris River basin, which is not necessarily the case on the Grand River. Studies have shown that while control of the Verdigris River flow is not critical as far as floods in the Arkansas River are concerned, storage of Grand River floods will benefit all the Arkansas River basin below Muskogee.

Control of both rivers would require the creation of nine reservoirs, all combining flood storage with at least one other use. The proper economical division between flood control and other beneficial uses is very important. Storage capacity limits the use of water for irrigation. The available reservoir storage also limits the amount of power that can be generated. Thus there will have to be a balance between irrigation or power development and flood-storage capacity.

Navigation also enters into the picture on the lower stretches of both rivers. In one respect power and navigation require the same consideration in design and operation of a reservoir—both need storage to insure a steady flow of water. Flood waters do not benefit either use. At the same time, a full reservoir has little value in the control of floods. Storage capacity must be available. Experience has shown that during the months of April, May, and June, or in September and October, floods can be expected in this area. Flood waters can



Pensacola Dam on the Grand River, Oklahoma

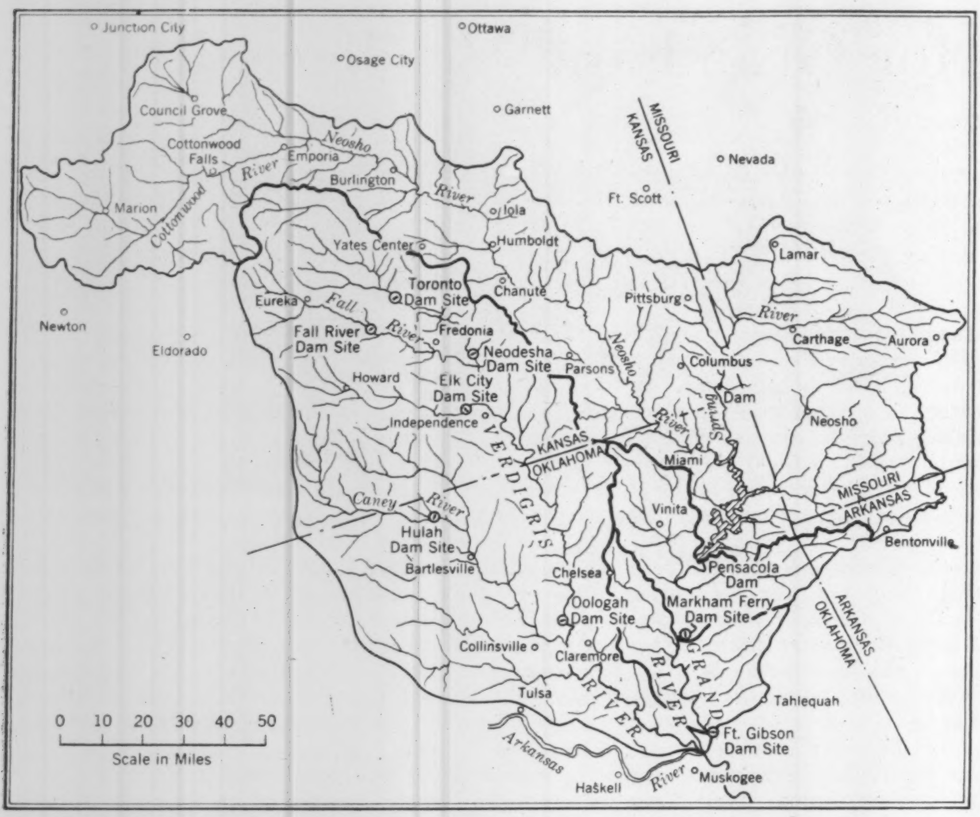

Junction City
Ottawa
Osage City
Council Grove
Garnett
Cottonwood Falls
Neosho
Emporia
River
Burlington
MISSOURI
KANSAS
Nevada
Marion
Cottonwood
River
Ft. Scott
Iola
Yates Center
Humboldt
Lamar
Toronto Dam Site
Chanute
Pittsburg
Eureka
Fall
River
Newton
Fall River Dam Site
Fredonia
River
Carthage
Aurora
Eldorado
Neodesha Dam Site
Parsons
Neosho
Columbus
Howard
Elk City Dam Site
Spring
Dam
Neosho
Independence
River
VERDIGRIS
KANSAS
OKLAHOMA
Miami
MISSOURI
ARKANSAS
Caney
River
Vinita
Hulah Dam Site
Bentonville
Bartlesville
Chelsea
Pensacola Dam
Oologah Dam Site
Markham Ferry Dam Site
ARKANSAS
OKLAHOMA
Collinsville
Claremore
GRAND
RIVER
Tulsa
Tahlequah
RIVER
0 10 20 30 40 50
Scale in Miles
Arkansas
Ft. Gibson Dam Site
Haskell
River
Muskogee

FIG. 1. DRAINAGE BASIN OF THE GRAND AND VERDIGRIS RIVERS

therefore be stored only during July and August or during the winter months of December, January, and February. Although storms do occasionally occur during these months, major floods are infrequent.

Reservoirs are planned for the Verdigris River at Oolagah, about 90 miles above the river junction at Muskogee, at the Neodesha site, another 133 miles upstream, and near Toronto, Kans., in the upper reaches of the river. Oolagah Reservoir is planned for a capacity of 815,000 acre-ft. In addition to its use for flood storage, it will also store water to operate navigation locks. Production of oil in the reservoir site should not delay construction, for the reservoir could be completely drained after each flood until the oil is recovered.

Three other dams are planned in this basin on tributaries. A dual-purpose reservoir is contemplated at the Hulah site on the Caney River about 15 miles above Bartlesville, Okla. Another is planned for the Elk River, above Independence, Kans., and a third on the Fall River, below Eureka, Kans. The total planned capacity of these six reservoirs is nearly 2,100,000 acre-ft.

On the Grand River, the huge multiple-arch dam at Pensacola Reservoir has been storing water since March 1940. This provides both flood control and power. All but extreme floods are taken care of. Power production in 1944 was 357,449,300 kwhr, and in 1943 it was 313,034,340 kwhr. Firm power of the plant is 225,000,000 kwhr. Details of this structure were given in an article by E. Lawrence Chandler in CIVIL ENGINEERING September 1939, page 529).

Fort Gibson Dam was under construction when activity was halted by the war. When completed it will generate an average of 170,000,000 kwhr of power and will have the capacity to store 922,000 acre-ft of flood water. This dam is to be a gravity-type concrete structure with the elevation of the top of the flood pool at 582, and that of the power po at 554. Storage for power wi be 365,000 acre-ft. Tota storage will be 1,287,000 acre ft. It is only 8 miles abov the junction of the Gran River with the Arkansas, an its operation will insure accu rate control of the Arkansa River at Muskogee.

A third dam is planned fo the Grand River at the Mark ham Ferry Site, about 30 mile below Pensacola. Surveys an plans for this structure hav been completed. It will gener ate an average of 160,000,00 kwhr, and be capable of storin 233,000 acre-ft of floo waters.

It appears that the con struction of these multiple purpose projects will materiall assist the development of th region. Cheap power will at tract industries. Industria workers will be drawn by th prospect of life in small com munities on subsistence farm irrigated by water from th reservoirs. Workers can buil for their own independenc while being employed by in dustries.

Municipal and industrial uses of the stored water ar mentioned last, not because they are not important, bu because a relatively small amount of water is required For example, the Oklahoma Ordnance Works was widel advertised as using 100,000,000 gal of water per day This is about 150 cu ft per sec. The real concern of thi plant is water to dilute its trade wastes, which are re turned to the stream. The works now asks for a mini mum flow of 1,000 cu ft per sec. In contrast with this the peak use of the city of Tulsa is about 30,000,000 ga per day. This is a lot of water when pumped and dis tributed through faucets to individual consumers. How ever, the amount in stream flow is only 45 cu ft per sec

Proponents of the projects are frequently asked th value of water. Water through the turbines yields abou 40 cents per acre-ft for power at 4 mills per kwhr. Irri gation water varies widely in cost per acre-ft, and also i amount required. Roughly a man can afford to pa about $5 per acre-ft.

The cost of water to a Tulsa consumer using 10,00 gal is $114 per acre-ft. The average cost for July wa $51 per acre-ft. Figures give the July consumption a 734,540,000 gal, at a cost to users of $114,922.

The only cost to the Oklahoma Ordnance Works is fo pumping. No charge is made for the water. The Gran River Dam Project also maintains a flow of 1,000 cu ft pe sec for dilution of trade wastes. No charge is made.

The development of the water resources in this are has only begun. I believe the future development of th state depends upon its use of water and flood contro Industries will depend more and more on water powe as oil and gas supplies diminish. The upland soils of th area are declining in fertility. Flood control of th streams will bring into profitable use thousands of acre of bottom lands. The uplands can be returned to gras and the rich bottom lands can be intensively cultivated

Engineers' Notebook

Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

A Floating Connection for Pier Pontoons Devised by the Seabees

By MARVIN Y. NEELY

COMMANDER, CIVIL ENGINEER CORPS, U.S. NAVAL RESERVE

DURING the assault phase at Tinian and immediately following the capture of Tinian Town, a pontoon er was constructed adjacent to, and extending out from, e Japanese masonry pier.

A unit of the first Navy Seabees to land were assigned e task of maintaining the pontoon pier. Heavy ound swells made this work very difficult. The harbor Tinian affords no protection from storms sweeping in om the sea, such as a land-locked or natural harbor, eakwater, or mole would provide.

Several failures of the standard hinge construction, ed to join sections of the pier, occurred. Repeated nergency repairs and new types of connections were ade but these lasted only for short riods of time. The pier maintenance tachment worked day and night under fficult conditions to keep the pier in eration. Finally a severe storm swept , completely broke up the pontoon pier, d heavily damaged the Japanese pier.

NEW PIER DESIGNED

Analyzing the requirements, Capt. P. J. alloran, M. Am. Soc. C.E., designed a w pier which embodies a floating bridge nnecting pontoon sections. The Seabee attalion installed it, and it has solved e problem. The Captain describes it follows:

"The floating bridge provides greater eedom in the complex movement between sections yet aintains continuous traffic despite inequal flotation used by differentials of loading, flooding of the cells, d the cycle of wave action.

HINGED SECTION PROVIDES A RAMP BETWEEN ADJACENT PONTOONS

"The simply modified pontoon section floats with relatively limited restriction between two adjacent ends of pontoon strings, guided in its gyrations by end-sliding girders riding in slides with wide clearances. The longitudinal motion is restrained by chains. The pontoon strings of the pier are independently anchored by underslung cables in prescribed manner.

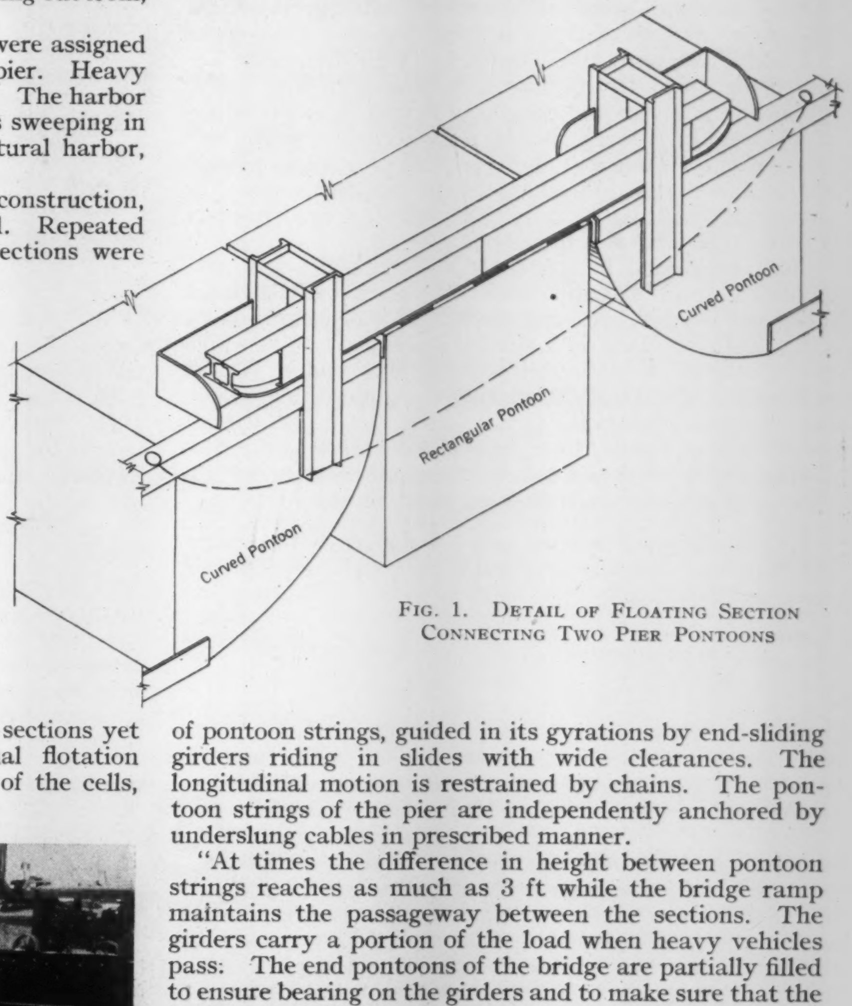


FIG. 1. DETAIL OF FLOATING SECTION CONNECTING TWO PIER PONTOONS

"At times the difference in height between pontoon strings reaches as much as 3 ft while the bridge ramp maintains the passageway between the sections. The girders carry a portion of the load when heavy vehicles pass: The end pontoons of the bridge are partially filled to ensure bearing on the girders and to make sure that the deck of the bridge at each edge remains on the same level with the adjacent section of the pontoon string. No connecting ramp plates are necessary.

"Adequate chafing plates between the sections of the bridge and the strings are necessary to resist the wear of continuous sliding action. The slides must be strongly built to resist strains which tend to throw the strings out of alinement."

Since the installation of these floating bridges, the maintenance of this pier has been reduced to a minimum· There has not been any failure of either of the bridges, although they have been subjected to continuous heavy traffic and considerable ground swell for nearly three months.

Development of California Bearing Ratio Apparatus

By W. J. TURNBULL, M. AM. SOC. C.E.

CHIEF, EMBANKMENT, FOUNDATION, AND PAVEMENT DIVISION, U.S. WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.

DURING the past two years, the U.S. Waterways Experiment Station, Mississippi River Commission, at Vicksburg, Miss., has been conducting several large-scale field investigations for the Office, Chief of Engineers, and the Engineer Board, Fort Belvoir, Va., involving airfield landing-mat and flexible-pavement foundation studies. In the conduct of these studies, the subgrades and base courses have been designed according to the California method, using the California Bearing Ratio (C.B.R.) test, as revised by the Corps of Engineers. (Use of this test by the Corps was described by Gayle McFadden and Reuben M. Haines, Associate Members Am. Soc. C.E., in their article, "Design of Airfield Pavements Developed by U.S. Engineer Department, CIVIL ENGINEERING for March 1945.)

Correct analyses and conclusions from these investigations could be reached only by very accurate control and evaluation of the subgrades and base courses as placed. Since it was essential that the foundation courses be evaluated immediately after placement, a field in-place C.B.R. apparatus was developed.

The basic idea for the new C.B.R. equipment was obtained from an apparatus which the Little Rock Engineer District had constructed and was using to check the C.B.R. in place on a flexible pavement. The apparatus utilized a calibrated proving ring and a Walker screw jack, the latter eliminating the undesirable pulsating effects of a hydraulic jack.

A detailed list of the equipment comprising the field in-place C.B.R. apparatus, as finally developed by the Waterways Experiment Station, is as follows:

1. Mechanical screw jack equipped with special swivel head for applying load to penetration piston, designed as follows:

Maximum pressure	10,000 lb
Maximum lift	5 in.
Detachable handle	6-in. radius
High-gear ratio	120 rev. per in.
Low-gear ratio	360 rev. per in.

2. Two calibrated proving rings with the following ranges—zero to 2,000 lb, and zero to 5,000 lb.

3. Circular penetration piston (3-sq. in. area, 6-in. height) and internally threaded pipe extensions with connectors in the following lengths:

2	$1^1/_2$-in. lengths
2	4-in. lengths
1	1-ft length
1	2-ft length
1	3-ft length

4. Dial gage (reading to 0.0001 in.) for measuring proving-ring deflection.

5. Dial gage (reading to 0.001 in.) with adjustable dial extension clamp for measuring penetration.

6. Support for penetration dial, made of 2-in. angle iron and approximately 8 ft long.

7. Circular steel plate, 10-in. diameter, weighing 1 lb, with a hole of $2^1/_{32}$-in. diameter cut in the center.

8. Surcharge weights in the following weights and dimensions:

2	10-lb weights, $8^1/_2$-in. diameter, slotted
3	20-lb weights, $8^1/_2$-in. diameter, slotted

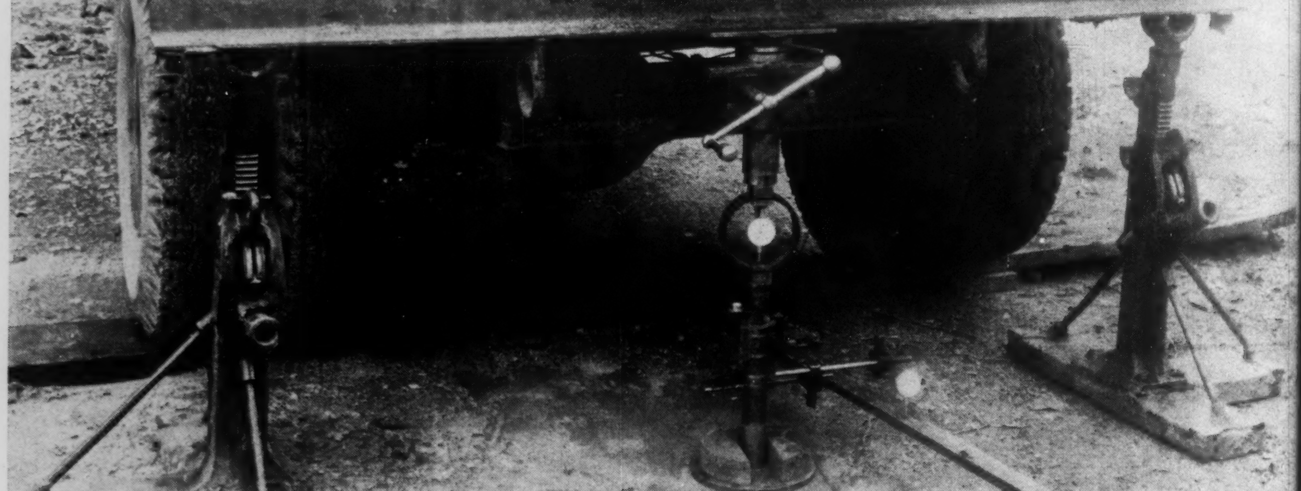
9. Truck equipped with heavy iron beam mounted across the rear end, with approximately 2-ft clearance above ground.

10. Two track jacks.

11. Other general equipment such as sample containers for moisture and density determination, spatula, rod level, straightedge, digging tools, etc.

CORRELATION WITH LABORATORY TESTS

Very good correlation has been obtained between field in-place C.B.R. tests and laboratory tests on undisturbed samples of clays and silts. Good correlation has also been obtained on plastic sand-clay-gravel. However, on clean non-plastic base-course materials, the field in-place values tend to be lower thant he corresponding design values obtained in the laboratory at the same density.



CALIFORNIA BEARING RATIO APPARATUS FOR EVALUATION OF SUBGRADES IN THE FIELD

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

eporting Critical Information to the Profession

o THE EDITOR: One of the obligations of every engineer is to ke public for the benefit of brother engineers any investiga ns or discoveries that advance the art. This is particularly e of any critical information that may help to avert engineering lures. Such publicizing should be prompt.

n connection with the Tácoma Bridge failure it has sometimes en stated that timely knowledge of the discovery of related enomena on other structures was withheld from the profession. is was not true in the case of two structures within the writer's owledge.

The Thousand Islands Bridge was completed and opened to affic on August 18, 1938. The writer promptly reported the wly discovered or rediscovered aerodynamic phenomena (and e installation for checking the oscillations) in an illustrated paper fore the Structural Division of the Society in October 1938, blished the following month in condensed form in CIVIL ENGI ERING (November 1938, pp. 716–719). Similarly, only two onths later, the writer's partner, Holton D. Robinson, M. Am. c. C.E., reported the corrective measures applied in the con uction of the Deer Isle Bridge (CIVIL ENGINEERING, January 39, pp. 3–6).

The writer has always sought to make his specialized informa n available to the profession in timely form.

D. B. STEINMAN, M. Am. Soc. C.E.
Consulting Engineer

ew York, N.Y.

lanning and the National Economy

To THE EDITOR: The report of the Committee on Postwar Con uction, presented by Mr. Kennedy at the Annual Meeting and blished in the March issue, admirably carries out the purposes r which the Committee was appointed. Since 1940 there has en an enormous investment in manufacturing, power plants, and forth for the production of war materials. Many processes ve been improved and manufacturing methods perfected. undreds of billions of dollars have been borrowed. Any further vestment of capital should be confined to changing over this ant and equipment to the production of civilian goods that raise e standard of living. The program of the Committee calls for an penditure of fifteen billion dollars. If this amount can be ob ined from state treasuries or private financing, well and good, but e national debt should not be increased after the war. That bt may prove to be the biggest postwar problem.

The unemployment problem was not solved after the last war d, as a consequence, this nation has been going into debt since 32, and it will continue to go into debt unless the problem is lved in the proper way. The cause of unemployment after a war the lack of buying power of fixed incomes from bonds and so on pay high wartime wages. In the Committee's report a na onal income of 140 billion dollars is considered adequate for full ployment. The value of the national income expressed in llars has but little significance in this connection—it is the actual ods and services produced that determine the standard of living d the buying power. It is these goods and services, after they ve been exchanged for dollars, that pay the wages. Thus the ore goods produced, the greater will be the buying power of ages, no matter what they are in dollars.

In 1915 the national income was $350 per capita, and that sum ultiplied by the population would have bought all the goods and rvices produced. In 1929 the income was $675 per capita but, 1915 prices, $300 would have bought the same goods and serv es. In 1939, with gold at $35 an ounce, the income was $525 per pita, but with gold at $20.67 this is only $315, or $267 per capita, 1915 prices. The nation was prosperous in 1915, but went into bt about four billion dollars in 1939 and there were over eight million unemployed. The cost of government was 760.587 million dollars in 1915, and 9,268,338 millions in 1939.

In 1929 the extra buying power of the money paid for World War I had been expended, and it was necessary for wages and prices to recede to prewar levels in order to restore the buying power of fixed incomes. At the lower prices, the lower wages had the same buying power as before. For nearly a century wages and the cost of living remained approximately at the 1915 level except during times of war but, as a result of the increased production made possible by technological improvements and the use of power, the buying power of wages increased greatly.

Since 1932 our policy has been to produce less wealth and to increase the cost of production, to pay wages for public improvements, but to restrict the production of food, clothes, and fuel by limiting working hours and increasing wages. The 40-hour week is a cause of unemployment and lowers the standard of living.

To restore prosperity, the laws that restrict production should be repealed, labor and management should cooperate to produce the most wealth, making all possible use of manufacturing facilities developed for producing war materials. Postwar plans should be directed towards decreasing the national debt.

ARTHUR B. FOOTE, M. Am. Soc. C.E.

Grass Valley, Calif.

Early Bridges Forerunners of Huge Modern Structures

TO THE EDITOR: I have been much interested in the series of articles, "Engineers' Odyssey to Europe—1889," by Messrs. Folwell, French, Provost, and Thomson, which appeared in the January, February, and March issues of CIVIL ENGINEERING. It is quite remarkable that the memories of these men have retained so many details of that interesting engineering excursion.

Mention was made of the unique features of the tubular bridges over the Conway River and Menai Straits and, also, of the Victoria Bridge over the St. Lawrence near Montreal. I believe that the significance of these structures, in the development of the art of bridge building, should be emphasized more than is usually done.

The Menai Straits Bridge was built about 1848 and, as stated, it marked an important step toward the use of rolled iron plates and shapes in structural design. It should, also, be noted that this was the first instance where the advantages of continuity were consciously utilized in bridge construction. The structure is actually a continuous girder and was designed as such after many calculations and experiments on models by both Robert Stevenson and William Fairbairn. It was the forerunner of the huge continuous truss bridges in use today.

ROBERT W. ABBETT, M. Am. Soc. C.E.

San Francisco, Calif.

The Case for a Channel Tunnel

TO THE EDITOR: The postwar days may revive that long-talked-of engineering project, the Channel Tunnel between England and France, as a future link in harnessing the forces of economic reconstruction and social understanding between Great Britain, France, Russia, Canada, and the United States.

While transport by air and sea will play a great part in the future, a highway and railway extending around the world would be a great step forward in practical communications—from London to Paris, thence to Alaska, via Berlin and Moscow, and over the great Alaskan Highway to New York, with branch roads to Capetown. and Calcutta. This should be more than a dream in the future.

The writer believes that the military experts of tomorrow won't hold the same views on the strategic menace of a tunnel under the English Channel, as did the Imperial Defense Committee and their Wellingtonian predecessors. The art of speedy demolition in these days of highly scientific warfare should readily dispose of this submarine link to a bridgehead. The neutralization of such a means of attack would be only a matter of hours. It is generally held that it was M. Matthieu who proposed the Channel Tunnel to Napoleon in the early days of the last century. This, however, was not the first proposal of the kind.

John Smeaton, the great English civil engineer, prepared a report in which he dealt with the physical possibility of making such a tunnel. The writer has a portion of this report, in Smeaton's own handwriting, dated 1777. Smeaton states that to "dig a tunnel under the sea between England and France may well be a practical one. The bed of that sea is of soft limestone that may be cut out like the vault of a cathedral, and where weak in strata could be builded under as in a bridge." He was apparently baffled by the problem of effective drainage and ventilation, or "through air," as he calls it.

In 1876 a protocol was signed between the governments of England and France for promotion of a tunnel scheme, and work was begun at Shakespeare Cliff, near Dover, and at Sangatte, near Calais, some 2,000 yd being bored. However, the Board of Trade stopped the work in 1882.

Surveys and tests have established that the sea bed between these two points is of blue gault about 10 miles wide and 190 ft deep. This formation would appear to be impervious to water and, indeed, an ideal geological formation for the construction of a submarine tunnel. Over 8,000 borings were made by the French engineers, and these proved the gault bed to be without a single break.

This geological report very clearly establishes that a tunnel is very practicable from the engineering point of view. The drainage system required would be simple in these days, and so would ventilation. To be sure, the provision of a tunnel for motor traffic might present greater difficulties in this respect as the continuous generation of carbon monoxide fumes in a space over twenty miles long is without question a problem. But surely the joint collaboration of the civil and ventilation engineering profession would find a solution. Danger of the sea's breaking in is out of the question, and the fire hazard would be no greater than in mines or tube railways.

The capital cost in 1914 was reckoned at £16,000,000 and a working cost at £420,000 with an annual profit of more than £1,000,000. Today the capital cost would possibly be much more than threefold the 1914 estimate.

Travel by tunnel to the Continent would simplify customs regulations and other irritations such as stormy crossings. It would, also, be a means to a more intimate and greater international friendship so material to the making of a world of peace.

Loughgall, Ireland COLIN JOHNSTON ROBB

Early Instrument Similar to Odograph

DEAR SIR: I was very much interested in reading Captain Faustman's article on the odograph, in the December number of CIVIL ENGINEERING, which has just reached me here, on active service on the Continent.

It may interest your readers to know of an early instrument, designed and made by Ferguson in Shanghai, China, some forty years ago with a similar, though limited, purpose in view. He called it the hodograph, and used it on a houseboat on the many creeks and canals of the Shanghai district, of which there were no maps at that time. This instrument is described in detail in the Proceedings of the Engineering Society of China about 1912 (being at the moment without my references, I am unable to verify the date).

Ferguson's hodograph relied on a special magnetic compass for the direction element, and on a trailing log (or propeller) for the distance element. It recorded the orientation of the boat at selected intervals of distance (number of revolutions of the "propeller") on a continuous strip of paper. The integration and plotting had to be done later by the operator.

The trailing log supplied the necessary power for driving the hodograph, as well as measuring the distance traveled through the water. An infinitely variable reduction gear of the friction-disc type wound the paper strip over a thin horizontal roller mounted under the compass. A cam action periodically lowered the compass unit into the recording position.

The compass consisted of a length of magnetized clocksp bent into a single turn spiral, mounted on a pivot on the extens of the axis of the thin roller mentioned previously. It was arranged that when lowered by the cam action its lower e (previously inked by contact with an inking pad) made an ink m on the paper where it crossed the roller. Owing to the spiral sh of the compass, the position of this dot in relation to the width the paper strip indicated the bearing of the boat at the instant marking. Pencil notes could be made on the strip to record la marks, bridges, times, and other topographical information to recorded on the chart. The whole instrument was mounted gimbals.

To calibrate the instrument, and to convert "water speed" i "ground speed," Ferguson used a simple fixed-range range find which enabled him with the aid of a stop watch to compute t actual ground speed by observing a tree on the bank, and meas ing the time it took to traverse the fixed range of the finder. varying the gearing he was then able to record the bearings at a desired fixed distance-intervals and so later to plot the rou traveled.

Although this instrument was crude and primitive, and subje to errors and accidents (such as weeds fouling the trailing propelle it was a very useful tool in plotting waterways hitherto uncharte and by this means Ferguson produced sketch maps of remarkab accuracy. It had the merit of working for long hours witho attention.

The new odograph is evidently an instrument of considerab precision. In addition to its present vital use by the Army, apparently has great possibilities in an adaptation to water-bor and air-borne transport for the reconnaissance and survey of rive and canals in undeveloped country, especially where air-photograp surveys are not possible. Its development reflects great credit those responsible for it.

SVEN E. FABER, M. Am. Soc. C.E.
Wing Commander, Hq. 5352 Airfi
Construction Wing, R.A.F.,
c/o British Liberation Army

Change to Metric System Advisable

DEAR SIR: In the "Items of Interest" department of the Fe ruary issue there is a piece entitled "Change to Metric System Ad vocated," with which I am in whole-hearted agreement. Durin the past year and a half I have had the opportunity to do enginee ing work in both England and France. The confusion that ca result from the difference between American and British gallo or tons is immediately apparent. In France, however, I hav never had any cause for misunderstanding the English and metr units. Moreover, I prefer to do my calculations in metric uni because everything works out nicely in decimals instead of, let say, feet and inches or a unit and a fraction, as in the case of othe measurements. Even as a civilian, I had a job involving the com putation of reinforcing steel in a building in Caracas, Venezue and the measurements were in the metric system. Needless say, the work involved in estimating this quantity of steel w considerably less than that required to compute steel in buildin in the states where measurements are in feet and inches.

My experience with people who are regularly using a new mea uring or money system, has been that it takes them about a mont to become sufficiently familiar with the new system. It wou take longer to convert our weighing and measuring equipment tha it would to change the people's habit of thinking in pounds thinking in kilograms. Sooner or later this change must ta place if the United States is to keep abreast of advances in physi and chemistry. The first year following the war when we a reorganizing for civilian production would be an excellent time f us to change our ancient system of weights and measures.

In our engineering section here we have an architect from t City of New York, a civil engineer from the Ohio State Departme of Highways, and a mechanical engineer from a large automoti concern. All of them heartily endorse the metric system a believe that it would greatly facilitate engineering work, ma production, and the everyday use of weights and measures encountered in non-technical work.

ARTHUR N. GOLDBERG
Technical Sergeant, U.S. Ar

APO 562, New York, N.Y.

SOCIETY AFFAIRS

Official and Semi-Official

Secretary's Abstract—Minutes of Board Meeting

Held at Palmer House, Chicago—April 16–17, 1945

HE BOARD of Direction met at the Palmer House, Chicago, ril 16 and 17, 1945, with President J. C. Stevens in the chair; present George T. Seabury, Secretary; Past-Presidents itman and Pirnie; Vice-Presidents R. E. Dougherty, Thomas, ward; and Directors Bakenhus, Breed, Bryan, Critchlow, W. Dougherty, Edwards, Gamble, Gardiner, Goodrich, Hatha- y, Koch, Saville, Scobey, Shannon, Thomson, Tipton, Tolles, lson, and Treasurer Trout.

nutes Approved

Records of the Board meetings of January 15 and 16, 1945, and nuary 18, 1945, were approved with minor corrections. Minutes the Executive Committee meeting of January 14, 1945, were proved as written. Transactions of the Executive Committee its meeting of April 15, 1945, were discussed and approved; y are reported herein as actions of the Board.

retary and Treasurer

Steps were taken looking toward the appointment of a new retary of the Society, to succeed George T. Seabury, who has ked to be retired. Details are withheld pending completion of angements.

Continuing in his present office, Charles E. Trout was re- pointed Treasurer of the Society.

nendment of By-Laws re Student Chapters

Action was consummated, following due Constitutional pro- dure, to amend the By-Laws, Article V, so as to eliminate the rds "Corporate Member," thus permitting Juniors to act as ulty advisers. That is, Section 2 (*h*) was revised to read as lows:

"A faculty adviser to the Student Chapter whose duties it shall to consult with and advise the Student Chapter on matters ating to the general conduct of the Chapter. The faculty viser shall be a member of the Society and shall be a member the faculty of the engineering school at which the Student apter is organized."

lumn Research Council

The Board discussed the new "Column Research Council" that in course of establishment. It is proposed to undertake exten- e and comprehensive studies of columns under the Engineering undation, with many cooperating organizations, including the ciety. As Society representatives on this Council, Charles A. lis, Bruce Johnston, and S. C. Hollister were designated.

ff Retirements Recognized

Taking cognizance of the resignation of Howard F. Peckworth, Assistant to the Secretary, and of Mark B. Owen as the Director the Committee on Postwar Construction, the Board adopted a solution of commendation with respect to each. Separate items ewhere in this issue indicate the wording of these actions.

ports Received

Reports of staff activities, of standing and special committees re received, with appropriate action as required in each instance.

lary Studies Authorized

In response to three specific requests, the Board authorized len P. Richmond, Jr., Assistant to the Secretary, to undertake lary surveys and classification studies for engineers, in the fol- wing instances: Los Angeles County, California; and the state ghway departments of Louisiana and Maryland.

dvisory Committee to Federal Works Agency

The Board accepted the invitation of Maj. Gen. Philip B. Flem- g, Administrator of the Federal Works Agency, to participate in Public Works Construction Advisory Committee to the FWA, d named as its representative E. Lawrence Chandler, of the ciety's Washington office.

Long Service Recognized

A special leave was granted Miss Eleanora Seiffert in recognition of 25 years of continuous service on the clerical staff at Headquarters.

Model Law on Registration of Engineers

The Board approved the proposal of the Committee on Registration of Engineers to hold a conference for the purpose of studying possible revisions in the Model Law.

Cancellation of Dues—Members in Armed Forces

It was voted to continue for the current year the policy of remitting Society dues for members in the Armed Services whose base pay is $2,400 per annum or less. Since January 1945 the dues of a total of 593 members have thus been canceled.

Postwar Construction

The Board listened to reports by G. Donald Kennedy, Chairman, and Frank T. Sheets and A. J. Ackerman, members of the Committee on Postwar Construction. It authorized an intensification of this activity for another year, particularly for increased cooperation with the Committee for Economic Development, and provided funds for so doing. As Director of the work, succeeding Mark B. Owen, who has resigned, Oscar L. King, Assoc. M. Am. Soc. C.E., of Knoxville, Tenn., was engaged. A separate item refers to this appointment.

Student Chapters

Recognizing the present-day difficulties of maintaining Student Chapters, the Board adopted a revised policy relative to the waiving of Chapter dues in justifiable cases.

New Technical Committee—Fluid Mechanics

Approval was given to the formation of a new Committee on Fluid Mechanics within the Hydraulics Division.

Committee Personnel

After reviewing Society status in connection with various continuing committees, it was decided to withdraw Society representatives on three joint committees having relatively minor interest for civil engineers. Steps were taken also for improving the methods of appointment to committees.

Constitution of American Standards Association

The Board voted to approve the proposed changes in the constitution of the American Standards Association to permit it to extend its activities into the fields of consumer goods.

Membership Elections

Applications for membership and transfer were considered in detail, with individual actions by the Board.

Engineers Joint Council

The Board considered and approved recent activities of the cooperative body known as the Joint Conference Committee, including the official change of its name to "Engineers Joint Council." The previous functions are to be continued under the new name.

Appointments

New selections or reappointments as Society representatives or members of committees were confirmed.

Other Reports

Many matters of administrative and professional interest were presented and discussed in detail. In some instances definite action was taken; in some, further developments were recommended; and in some, the decision was deferred.

Appreciation

A resolution was adopted expressing the unanimous thanks of the Board to the Illinois Section for its welcome and hospitality in Chicago.

Adjournment

The Board adjourned at 1:00 p.m., Tuesday, April 17, to gather again for its regular quarterly meeting on Monday, July 16, 1945, at a place later to be determined.

Nevada Highway Department Shows Progress in Salaries and Job Classifications

RECENT compensation and classification studies for the Nevada State Highway Department indicate that the recommendations made by the Society in 1940 have been followed very closely. The 1940 study was made by Mr. Richmond of the Society's staff, at the request of the State Highway Engineer.

Two related problems were encountered: the establishment of grades in both professional and subprofessional ratings, and the adjustment of salary rates in those grades. The ratings which existed in the professional grades before reclassification are shown in Fig. 1 (*a*). Following reclassification, lower grades were brought up to the recommended curve (Fig. 1, *b*). The most recent schedule lists grades and rates as shown in Fig. 1 (*c*). The deviation of the top brackets from the recommended salary curve is due to a statute restricting the salary of the State Highway Engineer.

Experience in the subprofessional grades was much the same is shown in the three parts of Fig. 2. It should be noted that t lower end of the schedule in both professional and subprofession grades was revised upward upon recommendation of the Societ as of February 15, 1945.

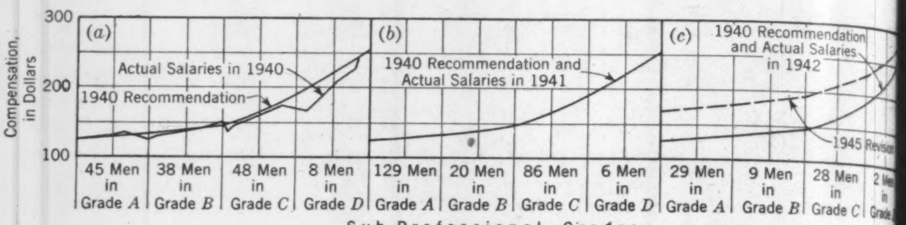


FIG. 2. RECOMMENDED SUBPROFESSIONAL RATINGS AND SALARY CLASSIFICATION COMPARED WITH ACTUAL CONDITIONS IN NEVADA STATE HIGHWAY DEPARTMENT

(*a*) Ratings in December 1940, Prior to Reclassification, (*b*) Ratings in July 1941, After Reclassification, (*c*) Present Ratings (February 1945)

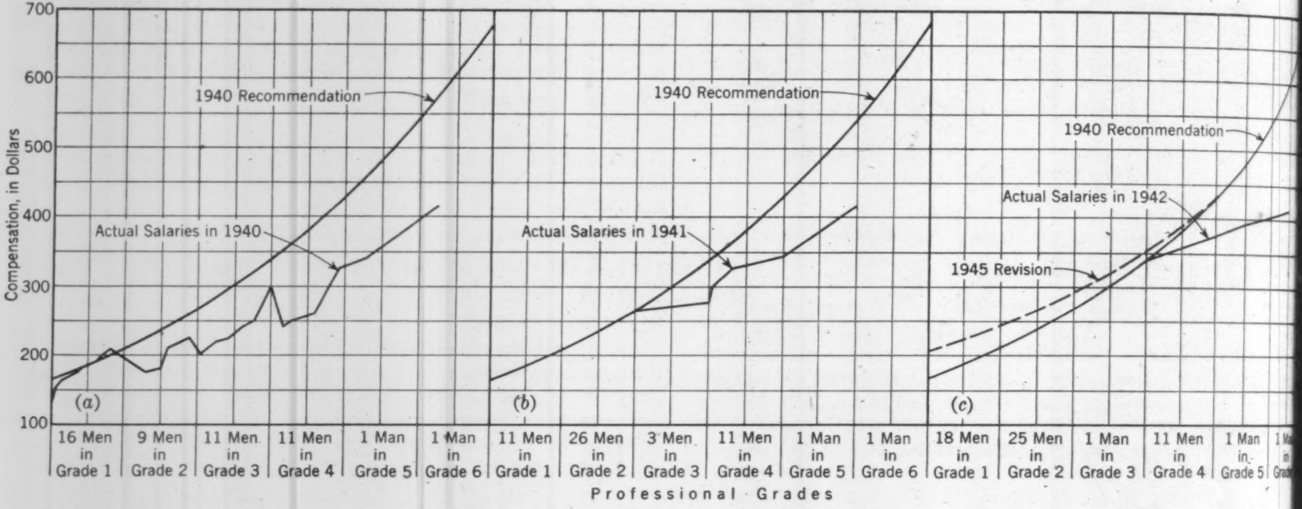


FIG. 1. RECOMMENDED PROFESSIONAL RATINGS AND SALARY CLASSIFICATION COMPARED WITH ACTUAL CONDITIONS IN NEVADA STATE HIGHWAY DEPARTMENT

(*a*) Ratings in December 1940, Prior to Reclassification, (*b*) Ratings in July 1941, After Reclassification, (*c*) Present Ratings (February 1945)

Services of Howard F. Peckworth Gratefully Acknowledged

AT ITS Chicago meeting on April 17, the Board of Direction considered the situation of the Society's employment activities in view of the recent resignation of Howard F. Peckworth, Assistant to the Secretary in charge of this particular phase of the work. The Board's acknowledgement of this service and its sentiments on the occasion were expressed in the following resolution, unanimously adopted:

"WHEREAS Howard F. Peckworth has served on the Staff of the American Society of Civil Engineers for almost four years with various important assignments—for one year as Editor of CIVIL ENGINEERING and for the past three years in implementing the policies of the Committee on Employment Conditions; and

"WHEREAS he has performed his duties with a high degree of competence, bringing credit to the Society and exceptional benefits to the engineering profession; now

"*Be it Resolved* that the Board of Direction of the Society, in session at Chicago on April 17, 1945, unanimously expresses to Mr. Peckworth its appreciation for his effective service."

Resolution in Appreciation of Services of Mark B. Owen

ONE OF THE important matters before the Board of Directi at its Chicago meeting in April was the current activities a future plans for the Society's Committee on Postwar Constructi The resignation of Mark B. Owen as Director of this activity w noted with regret. In recognition of his work the following re lution was drawn up and adopted as a part of the Board's record

"WHEREAS Mark B. Owen has served as Director for the Com mittee on Postwar Construction of the American Society of Ci Engineers for the past year; and

"WHEREAS he has resigned his office as Director for this Com mittee effective April 30, 1945; it is hereby

"*Resolved that* the Board of Direction of the American Socie of Civil Engineers at its spring meeting in Chicago, Ill., on Ap 17, 1945, by unanimous vote expresses its deep appreciation of t valuable services rendered by Mr. Owen—in organizing the st of this Committee, in developing its activities, and in carrying vigorously and successfully the program of the Society for stim lating the preparation of construction plans for the postwar yea immediately ahead."

Group on West Coast Forms Employees Association

Organization of the Southwest Washington Association of Pro- ssional Engineering Employees became a fact on January 16 with e adoption of a constitution. For the information of other groups, e text of this constitution is here reproduced.

ARTICLE I—NAME AND PURPOSES

The name of this organization is the "Southwest Washington Association of Professional Engineering Employees."

The purposes of the "Association of Professional Engineering mployees" are to improve, protect and maintain the employment onditions of the members of this Association in fair and reasonable elationships between them and their employers.

To effect these purposes this Association is declared hereby to be ady to form and assist appropriate bargaining units, composed clusively of "Professional Engineering Employees" residing or mployed within the area limits stated hereinafter and members f this Association, to assume the rights and privileges to be ccorded them as sole bargaining units under agents of their own hoosing for the purpose of entering upon all appropriate collective argaining procedures related to their compensation, hours and orking conditions.

ARTICLE II—QUALIFICATIONS FOR MEMBERSHIP

Membership in this group shall be confined to those "Profes- ional Engineering Employees" residing, or employed within the llowing counties in the State of Washington: Grays Harbor, Mason, Pierce, Lewis, Thurston, Pacific, Wahkiakum, Cowlitz, Clark and Skamania.

The definition of "Professional Engineering Employees" is as ollows:

"The designation 'Professional Engineering Employees,' used in the sense that persons capable of being so designated may join with others similarly capable of being so designated for the purposes of collective bargaining separately from any other group composed of persons not capable of being so designated, shall be that of only those who, excepting employers or those to whom employers have delegated managerial responsibility with respect to employment conditions, possessing an intimate knowledge of mathematics and the physical sciences, gained by technological and scientific education, training and experience, and in a position of trust and responsibility, apply their knowledge in controlling and converting forces and materials to use in structures, machines, and products, and whose work requires the exercise of discretion and judgment, is creative and original and of such character that the output cannot be standardized; and those who, without the experience set forth, but having been graduated from an approved educational institution and having received the degree of Bachelor of Science or its equivalent, in Engineering, are engaged in engineering work."

ARTICLE III—EVIDENCE AND CONDITIONS OF MEMBERSHIP

(1) The "Committee on Employment Conditions" elected from he members of this Association shall review each application for embership in this Association and determine whether or not the pplicant is a "Professional Engineering Employee" in accordance ith the above definition.

(2) An applicant for admission to this Association must submit n writing to the Committee on Employment Conditions his educa- ion and experience record in sufficient detail to allow that Com- mittee to pass judgment on the applicant's qualifications for mem- ership in this Association. The applicant must state in writing hat it is his desire to have membership in this Association and that e has a community of interest with the other members of this ssociation.

(3) Upon approval of his qualifications by the Committee on Employment Conditions and the payment of the dues stipulated erein, a "Professional Engineering Employee" shall be considered member of this Association.

(4) Any member who shall become unemployed shall continue o be a member of this Association so long as he pays his dues as rovided for membership in this Association. Unemployed "Professional Engineering Employees" who are eligible for mem- ership may be accepted to membership in accordance with these Rules and Regulations.

(5) With the consent of the Committee on Employment Conditions, previously obtained, a member of this Association may be a member of another bargaining group.

(6) A member in good standing shall be one who is not in arrears of dues. A member whose dues are not paid by March first of the current year shall automatically lose his membership and shall lose the privileges of nominating, making or seconding motions or voting and he shall not hold office nor participate in meetings of the Association.

(7) No person shall be forced to be a member of this Association against his will.

(8) Members may be suspended or expelled for willful violation of these Rules and Regulations or for refusing to pay dues or for acting in any manner or engaging in any practice which will tend to bring discredit on the honor or dignity of the Engineering Profession.

(9) Any member of this Association who changes either his residence, or place of employment to the area of any other similar Association or Group of Professional Engineering Employees, may become a member of that Association or Group, or may remain a member of this Association as he shall elect.

(10) Each member of this Association shall authorize the Committee on Employment Conditions, or a subcommittee appointed for that purpose, to represent him in all conciliations or negotiations short of active collective bargaining procedures. However, this shall not restrain any member of this Association from negotiating with his employer in relation to his own compensation, hours or conditions of employment.

(11) The Committee on Employment Conditions shall administer its functions in accordance with the general directions of the members of this Association to the end that this Association shall be self-administered, under leaders of its own choosing, and self-financed.

ARTICLE IV—POLICIES AND PROCEDURES

(1) It shall be the established policy of this Association and of its Committee on Employment Conditions to maintain the type of dignity and conduct consistent with the term "Professional Engineer." It shall be its intent to recognize the spirit and the intent of all contractual relations developed.

(2) No agreement will be entered into which involves strikes, boycott, check-off or closed shop, nor shall this Association attempt to exercise any control over what employee shall be employed in preference to another employee, nor shall it attempt to dictate the number of employees to be engaged, nor pass upon the competency of an employee to perform the work assigned to him.

(3) The Committee on Employment Conditions shall consist of three members, each to be elected for a term of three years except at the start; one member to retire each year. For the years 1944, 1945 and 1946 the Committee shall consist of three members of the Tacoma Section of the American Society of Civil Engineers. Following the year 1946, any member in good standing of this Association may be elected to the Committee on Employment Conditions. The Committee shall elect from its membership a Chairman, a Vice-Chairman and a Secretary-Treasurer, each of whose terms of office shall be for one year, and each of whom may be reelected so long as he remains a member of the Committee. Each member of the Committee may succeed himself for one consecutive term of three years.

(4) The members of the Committee shall be elected annually by letter ballot from the members of this Association who have paid the dues stipulated for them in Section 8 of Article IV of this Constitution. Vacancies in the Committee's membership shall be filled by letter ballot as occasion may require. The names of candidates for election to the Committee, at either the regular time for election or to fill a vacancy, shall be placed on the ballot for election by nomination from the floor at the time of this Association's annual meeting or upon the written request, previously received by the Secretary-Treasurer of the Committee on Employment Conditions, from ten members of this Association. Canvass of ballots and declaration of election shall be made by the Committee on Employment Conditions not less than ten days after date of issue of the ballot.

(5) The Committee shall hold meetings at such times and places as are necessary for the transaction of its business. It shall keep a

record of all its proceedings. It shall hold an annual meeting open to all of the members of this Association some time within the month of December for the purpose of presenting and filing reports, including a public report of its receipts and expenditures and their sources and purposes, and for the transaction of such other business as properly may come before it or the membership of this Association. Other meetings of this Association may be called, after due notice to all members, by the Chairman of the Committee on Employment Conditions or upon the petition of ten members of this Association. All meetings of the Committee or of this Association shall be presided over by the Chairman of the Committee or in his absence by the Vice-Chairman.

(6) When the Committee shall act in conciliation or negotiation with respect to any certain employer, any member of the Committee who shall have a direct interest in the outcome of the bargaining may withdraw from participation in that procedure and in such instance the Committee shall select and designate another Professional Engineering Employee to act as his alternate in that procedure.

(7) The expenses of the Association shall be defrayed by annual dues collected by the Secretary-Treasurer of the Committee from each member of this Association.

(8) The dues shall be $2.50 per year per member. These may be changed, after due notice has been given to all members of this Association, by affirmative vote of not less than two-thirds of the members of this Association in good standing voting, provided the total number of voters shall be not less than a majority of the members of this Association.

(9) All members of the Committee on Employment Conditions shall deliver to their respective successors all property in their possession belonging to this Association. All of the funds and property of this Association shall be deemed to be held in trust for the benefit of the members of this Association.

(10) The Committee on Employment Conditions may appoint various subcommittees such as experience shows would be helpful in attaining the objectives of the Association.

(11) The Committee shall keep the members informed concerning any State or Federal legislation or laws affecting Professional Engineering Employees along the lines of collective bargaining and other conditions pertaining to their welfare.

(12) This Association shall work in cooperation with other similar organizations toward the common goal of improving the economic status of the Professional Engineering Employee and his relations with his employer.

(13) In the appropriate collective bargaining units within any place of employment formed and assisted by the Committee, the representative of any unit, in order to have authority to act, must be chosen by a majority of the employees in that particular appropriate unit involved.

ARTICLE V—AMENDMENT

(1) This Constitution may be amended, after due notice has been given to all members of this Association, by affirmative vote of not less than two-thirds of the members of this Association in good standing voting, provided the total number of voters shall be not less than a majority of the members of this Association. Such voting shall be done either at a regular or special meeting of the Association or by letter ballot distributed to all members of this Association.

(2) No amendment shall be effective which would have the effect

(*a*) of affiliating this Association with any other group or Association composed of other than "Professional Engineering Employees" as defined herein, or

(*b*) of diminishing the purposes of this Association to maintain fair and reasonable relations between its members and their employers, or

(*c*) of violating such contractual relations as may be developed between this Association and employers, or

(*d*) of bringing discredit on the honor or dignity of the Engineering Profession.

ADOPTED January 16, 1945, at a meeting of the Southwest Washington Association of Professional Engineering Employees:

COMMITTEE ON EMPLOYMENT CONDITIONS
Ronald Knapp, *Chairman*
Arthur Johnson, *Vice-Chairman*
E. H. Thomas, *Secretary-Treasurer*

Oscar L. King Becomes Director of Society Committee on Postwar Construction

A NEW DIRECTOR has been chosen for the Committee on Postwar Construction—Oscar L. King, Assoc. M. Am. Soc. C.E., of Knoxville. He succeeds Mark B. Owen, M. Am. Soc. C.E., who has held the office for the past year and whose resignation has been submitted.

The appointment of Mr. King was ratified by the Board o Direction at its Chicago meeting in April. He is expected to take over his new office shortly, carrying on the activities which the Committee has been pursuing.

Most of Mr. King's experience has been in the Tennessee Valley. He is a 1926 graduate of the University of Tennessee and has served in various capacities with the Tennessee Eastman Corporation and the State Department of Highways. For eight years, 1934–1942, he was city engineer for Kingsport, Tenn. Then for two years he was employed by the Portland Cement Association as its field engineer in that territory. He comes to the Society service after a year as Director of Public Service for the City of Knoxville.

OSCAR L. KING, ASSOC. M. AM. SOC. C.E.

All this work should fit him for his new task. He has a good technical training; his experience in public relations and in engineering contacts has been valuable; and h has had to exercise executive responsibility. Thus, from th standpoint of background as well as engineering experience, h should be fitted for the promotion and technical features of thi work on Postwar Construction. The Committee expects throug him to continue its effective service in this important field.

The Engineer in Foreign Service

XIII. *Saga of the South Seas*

By G. E. TOMLINSON, M. AM. SOC. C.E.
LIEUTENANT COLONEL, MARINE CORPS

WE HAVE learned to respect the bigness of the sometimes-not-to Pacific Pacific Ocean. It covers 64,000,000 sq miles—an are larger than all the land area on the globe. It is not as salty as th Atlantic (with the result that it is not as buoyant, and conse quently a more difficult place in which to swim) but neverthele it's much too salty for drinking purposes—despite the fact tha most of us take about 30 grains of salt daily to replace that lost i perspiration. Of all the oceans it's the bluest, the warmest, an the deepest. An officer, in talking to one of the colored messme as he looked over the side of the ship remarked: "That's a lot o water," and received the reply, "And you'se just looking at th top of it."

The islands of the north and west Pacific are for the most part o volcanic origin and are in varying stages of geologic developmen In some groups, the original mountain peak has sunk below th surface. However, as the mountain sinks, a fringing coral re forms on its shoulders, and the coral being a living thing, grow upwards, frequently as fast as or faster than the land mass sink Guam and Guadalcanal are good examples of this conditio Still sinking, the mountain supports a barrier reef with a lagoo between the island and the reef. After the mountain proper ha sunk completely, only the reef remains and we have a typic acific atoll. These atolls all follow the same pattern—a chain of mall islands enclosing, more or less continuously a lagoon. Some f these lagoons are very shallow and some vary in depth, but all re considerably more shallow than the ocean beyond. Practically ll the larger atolls have passes between the rim islands through hich ships can navigate, and the deep portions of the lagoon make xcellent anchorages.

Sees Palau Group

I started out to tell you something about the Palau Group of the arolines. These islands are about 530 miles east of Davao in the hilippines. The natives are, generally speaking, short, slender, nd lithe. The color of their skin is light brown and their hair is ark brown or black, usually wavy but sometimes fuzzy.

I don't suppose you have ever heard of Ulithi—I hadn't either ntil a few months ago. However, I learned quite a bit about this toll before we made our "visit." We landed sometime ago, but I as not privileged to write about it until after the official announcement of our occupation. Ulithi is the largest atoll in the Western arolines—about 20 miles long and 10 miles wide. There are ractically no able-bodied natives. Almost all those seen were hildren or old people, the only exceptions being pregnant women nd those with small babies. It is probable that the Japs had oved all the others to some of their more active possessions for bor or other purposes.

There were two things I expected to see at Ulithi and didn't; ne was blackened teeth, and the other was cartwheel money. At ap, money consists of huge stones similar in size and appearance the 18th century mill wheels. These "wheels" are about a foot hick and some of them are 8 or 9 feet in diameter. Most of this money" was of aragonite stone, quarried on Palau and transported Yap, 250 miles away (never say the natives are not good navi-ators). About 70 years ago a trader made himself almost king of ap by quarrying, on a large scale, this millstone money on Palau nd bringing it by ship to Yap.

Up at Ulithi the weather was very hot but we usually had a good reeze; that was not true at Palau. In many respects Palau was orse than Bougainville. It was much hotter, but fortunately rier. The ground was so rocky that I could hardly dig a decent it trench. Also, luckily for us, there were practically no mos-uitoes. We did have some huge sand crabs with ferocious looking laws which bit one or two fellows, but did not come in my immedi-te area.

The Perfect Island

In my travels over the Pacific I've had occasion to stop over at a mall island called Palmyra several times. Despite its smallness it aught my fancy from the first. Although called an island, it is eally an atoll composed of about 54 islands. It was given its resent name by a Captain Sawle who sought shelter there in 1802 ith his ship, *Palmyra*. There are 16 known species of plants on he island. Most conspicuous are the coconut palms, many of hich have been set out by man, but the majority are probably the esult of natural processes.

Palmyra is noted for its crabs: hermit crabs, land crabs, and oconut crabs, such as are well distributed over most or all of ceania. The hermit crabs are the scavengers of the islands; hey are responsible for the fact that one seldom sees a dead bird or rotting coconut. The atoll has a small but interesting insect una. It has no butterflies and, luckily, no mosquitoes. The goons and reefs are alive with many forms of marine life—sea ugs, crustacea, mollusks, eels, and myriads of fish.

The fish range in size from that of the tiny silvery minnows in hools to the predatory fish such as the large, unwelcome, and er-inquisitive sharks. I'm sorry I didn't have access to any shing gear; I believe I would have done O.K.

If there was ever a tiny speck of earth sitting out in the middle nowhere, this is it. It is a beautiful spot and would be ideal for a wl or game sanctuary. However, its future will probably be etermined by the use that Pan American Airways and the other rans-Pacific airlines decide to make of it.

Life out here goes on as usual. It is an "in-between" or mixture the free, easy going, romantic (?), island life of Hollywood and e life of the fighting man, as described by the "blood and sweat" ar correspondents.

(*Condensed from February 1945 "Tennessee Valley Engineer," ublished by the Society's Tennessee Valley Section.*)

XIV. Burma Visit

By Brig. Gen. S. C. Godfrey, M. Am. Soc. C.E.

Air Engineer, U.S. Army

My China trips afforded incidents and local color that I could relate without violation of the censorship rules. Let me try to do the same with reference to my last visit to Burma. Walter Lippmann says that what the Army wants above all from the people at home is a truer understanding of the nature and magnitude of their task overseas.

It's an easy hop now to Myitkyina—a Myitkyina that still recalls the straining weeks last summer, when amid monsoon torrents, with the Japs holding on to the town a mile away, our aviation engineers succeeded in keeping open and improving the miserable little captured strip that was known as Myitkyina airfield. Keeping open a life line for the ground troops indeed—for the head of the Ledo Road, itself beset with monsoon difficulties, was many miles in the rear. For six months, therefore, Joe Stillwell's Northern Combat Area Command, consisting of Chinese, British and U.S. Forces, had to be supplied entirely by air. This meant that the 10th Air Force, in addition to its combat missions of bombing and strafing, had to fly in all the food and ammunition and other supplies—amounting during this period to some 100,000 tons or, say, 100 train loads. Some of this was "dropped" to isolated detachments, let down by parachutes or simply pushed out of the plane. The great bulk of it was landed at this one little airfield, where for days at a time landings and take-offs occurred nearly one a minute. Of course all the engineers and their equipment—first the little "airborne" types, then the big bulldozers (count 'em, 48)—had to come in the same way, by air. Going back, the planes, which otherwise would have been empty, carried out many a wounded soldier.

Those days are behind us, and Myitkyina is now in the rear area, with several first-class airfields that the 10th Air Force Engineers of Mone Asensio have hewn out. The NCAC, now under Dan Sultan, has pushed well to the south, converging with the advance of the British Fourteenth Army on Mandalay from the west. But even through the dry months, and with such use of roads as was possible, the main reliance of the ground forces (including the 14th Army) has been on air supply. And the efficacy with which that supply task has been carried out by the Air Forces, in all kinds of weather, is astounding. This task has of course called for airfields—airfields-in-a-hurry, airfields close to the front.

Going forward to the 10th Air Force Headquarters, I spent the night with Howard Davidson. Few buildings are standing in ——, once a city of 10,000 inhabitants. New construction for the headquarters is of the simplest—being of light frame with burlap walls and doors. Most of the men are in tents. All are fairly comfortable, and the meals are very good. A roomy Red Cross Club affords a reading room, game room, snack bar.

I do wish I could do justice to the magnificent scenery! The Irrawaddy is a majestic stream, flanked with rugged hills, and may be compared perhaps to our Columbia River. As contrasted with India, Northern Burma certainly is the "cleaner, greener land" that Kipling described. At one point our course skirted a section of the old Burma Road where it climbs dizzily to a 4,500-ft elevation, and among these lofty mountain ranges one gets away from the intense heat of the plains.

Airfields aplenty. Airfields-in-a-hurry, at least in some cases, as when we stood on a newly constructed runway in territory which three days earlier had been occupied by the Japs. In this dry weather, construction does not always have to be of permanent character.

It was good, in the shower bath, to get the thick layer of Burma dust out of our ears and skin and hair.

One other incident I will describe—a visit to a bazaar or market place. The people of —— are coming back, resuming their trading, and here at a score of roadside stalls were vegetables for sale (even green corn), and the various wares and knick-knacks that one would see in a ten-cent store. Here again I thought of Kipling, for the sales-ladies who tended these stalls were "neater, sweeter maidens" than one finds in India.

On arriving at Calcutta yesterday, Mohammed, my 18-year-old bearer, greeted me with the cheerful news that he was going away for six weeks to Bahar, 600 miles distant, to marry a 13-year-old girl he had never seen. She would then live with his old mother, while he came back here to work. Somehow I prefer the way we arrange these matters at home.

Mark Owen Enters Consulting Practice

JUST a year ago CIVIL ENGINEERING carried the announcement of the appointment of Mark B. Owen as Director of the Society's Research and Development Division of the Committee on Postwar Construction. In this one short year, programs of postwar planning have been stimulated both at national and community levels. Mr. Owen has also successfully coordinated this work with the activities of the Committee for Economic Development, the U.S. Chamber of Commerce, and other national organizations.

MARK B. OWEN, M. Am. Soc. C.E.

From his office in New York City, he prodded the Society's Local Sections and public officials throughout the nation to active effort in the planning program. Monthly bulletins carried the picture of works already planned as compared with the Committee's goals. Other circulars and countless letters carried the story to every corner of the country. In personal appearances also, Mr. Owen carried the message to many gatherings of engineers and officials.

From New York Mr. Owen is moving to Indianapolis, Ind., where he will become a partner of the Russell B. Moore Company, consultants specializing in water works, sewerage, sewage treatment, refuse disposal, airports, and highways. It is evidence of his persuasive powers that now Mr. Owen wants to roll up his sleeves and take an active part in actually preparing the blueprints he has talked so much about.

Appointments of Society Representatives

JULIUS ADLER, M. Am. Soc. C.E., and **LYLE L. JENNE**, Assoc. M. Am. Soc. C.E., were appointed to represent the Society at a meeting of the American Academy of Political and Social Science, held in Philadelphia in April. **WILLIAM H. CHORLTON**, M. Am. Soc. C.E., was named alternate delegate.

WILLARD E. LOFGREN, Assoc. M. Am. Soc. C.E., has been appointed to represent the Society on the National Committee for Postwar Traffic Safety.

GEORGE T. SEABURY, M. Am. Soc. C.E., has been appointed the Society's representative on the executive committee of American Engineering Council, to take the place of Past-President D. H. **SAWYER**, who was a vice-president of Council at the time of his death.

News of Local Sections

Scheduled Meetings

ALABAMA SECTION—Dinner meeting at the Admiral Semmes Hotel on May 11, at 7:30 p.m.

CENTRAL ILLINOIS SECTION—Dinner meeting on May 22, at 6 p.m.—joint meeting with the Champaign County Chapter of the Illinois Society of Engineers.

CLEVELAND SECTION—Dinner meeting at the Cleveland Engineering Society on May 18, at 6:30 p.m.

COLORADO SECTION—Dinner meeting at the Oxford Hotel on May 14, at 6:30 p.m. (Joint meeting with the Student Chapters.)

DAYTON SECTION—Luncheon meeting at the Engineers' Club o May 21, at 12:15 p.m.

FLORIDA SECTION—Inspection and dinner meeting at the S Johns River Shipbuilding Company on May 4, at 6 p.m.—inspection from 6 to 8 p.m.; dinner at 8 p.m. (Place of dinner to be fixe at later date.)

KENTUCKY SECTION—May meeting at the Arts Club, Watterso Hotel, in Louisville, on May 4. Program will consist of thre papers from the Student Chapters at the University of Louisvil and the University of Kentucky.

LOS ANGELES SECTION—Dinner meeting at California Institu of Technology on May 9, at 6 p.m.

MARYLAND SECTION—Dinner meeting at the Engineers' Cl on May 24, at 7 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineerin Societies Building on May 16, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Southern Tave Restaurant on May 3, at 7 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Minneso Union Club, University of Minnesota, on May 7, at 6 p.m.

PHILADELPHIA SECTION—Meeting at the Engineers' Club o May 8, at 7:30 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the El Club every Tuesday at 12 m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel o May 28, at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Foru at the Engineers' Club on May 24, at 5–45 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Chattanooga Sub-Section with local groups of the Founder Societies at th China Restaurant on May 8, at 6 p.m.; dinner meeting of th Knoxville Sub-Section at the S & W Cafeteria on May 9, at 6 p.m

TEXAS SECTION—Luncheon meeting of the Fort Worth Branc at the Blackstone Hotel on May 14, at 12:15 p.m.; luncheo meeting of the Dallas Branch at the Adolphus Hotel on June 4, a 12:15 p.m.

Recent Activities

BUFFALO SECTION

The February 23d meeting was sponsored by the Engineerin Foundation of Buffalo, of which the Buffalo Section is a cooperatin member. The principal speaker was G. Edward Pendray, assista to the president of the Westinghouse Electric and Manufacturin Company, and one of the country's foremost proponents of rock power. Mr. Pendray gave an illustrated talk on rockets. O March 20, Col. Allen J. Greer addressed the Section, giving th group an interesting résumé of the war situation to date.

CENTRAL ILLINOIS SECTION

The technical program at the March meeting of the Section— held in Urbana on the 23d—consisted of a talk by A. E. Cumming Mr. Cummings, who is research engineer for the Raymond Co crete Pile Company, of New York, described heavy constructio work in Venezuela and Colombia. During the evening Pr Harold E. Babbitt reported on the present status of the new b for registration of professional engineers.

CENTRAL OHIO SECTION

Society Director Frank C. Tolles attended the March 15 meeting of the Section and gave a brief report on current Socie activities. Later in the evening C. A. P. Turner, Columbus co sultant, read a paper on "The Universal Constant of Chemic Matter Coordinated for Practical Use." A general discussion Mr. Turner's paper concluded the technical program.

CINCINNATI SECTION

On February 28 the Cincinnati Section participated in a joi meeting with the local groups forming the Technical and Scienti Societies Council of Cincinnati. The principal speaker for t occasion was Eugene E. Wilson, president of both the United A craft Corporation and of the Aeronautical Chamber of Commerc Mr. Wilson's subject was "Air Power for Peace."

Cleveland Section

'Eighteen Months at the Battle Front with an Evacuation spital" was the subject of discussion at the March meeting of Cleveland Section, the speaker being Lt. Col. Edward H. shinger. Colonel Hashinger, who is Chief of Medical Service, edical Corps, Crile General Hospital, organized the 77th Evacua- n Hospital from the faculty and nurses of the University of Kan- School of Medicine. The group arrived in England in 1942— time to care for men who had been wounded in the Dieppe raid— d later saw service in both the North African and Sicilian cam- igns.

Colorado Section

The list of guests at the March 12 meeting of the Section in- ded Maj. R. D. Brown, a former officer of the Institute of Civil gineers of Great Britain, and D. C. Milne, of the Manchester ngland) Shipyards. Both gave interesting talks on wartime ngland. The technical program consisted of a talk by R. P. Baron, assistant manager of the Midwest Steel and Iron Works ompany, of Denver, and the showing of two Navy films by Al venbury, of the U.S. Navy Public Relations Office in Denver. r. LeBaron spoke of the part played by local steel companies in e building of ships for the Navy.

Connecticut Section

At the annual meeting—held in New Haven on January 24— esident Stevens presented certificates of life membership to ancis Winfield Collins, John C. Tracy, and Max W. Weir. ank N. Spencer was a recipient in absentia. Secretary George Seabury then described the duties of the Society staff, and Mr. evens gave an interesting address on Society activities. During e evening the following officers were elected for the coming year: arence W. Dunham, president; William S. Wise, vice-president; d Harold L. Blakeslee, secretary-treasurer. Part of the March h meeting was devoted to business discussion and the appoint- ent of committees. Then Thorne Perry, of the Hamilton Pro- eller Division, of the United Aircraft Corporation, spoke on the bject of "Variable Pitch Propellers."

Dayton Section

Speakers at the March meeting of the Dayton Section were lbert Schroeder, city engineer of Piqua, Ohio, and William orry, secretary of the Piqua Chamber of Commerce. Both oke on the subject, "A Small City Looks Ahead," describing iqua's postwar plans for relocating streets, constructing recrea- onal sites, and in other ways improving and modernizing the city.

Florida Section

At the March dinner meeting a group of engineers discussed the mely subject of the proposed state board for water control and nservation. Those taking part in the symposium were A. P. lack, professor of chemistry at the University of Florida, who ve a general picture of Florida's water problems; F. A. Eidness, nitary engineer for the Florida State Board of Health, who dis- ussed industrial water shortages; George E. Ferguson, district gineer for the U.S. Geological Survey at Ocala, who explained e natural factors responsible for the deficient water supply; d Harold A. Scott, hydraulic engineer in the U.S. Engineer Office Jacksonville, who emphasized the vital need of a water-control gency for postwar planning. A lively discussion followed the heduled talks; and a resolution, endorsing the creation of a body y the state for the control and conservation of water, was passed.

Georgia Section

A talk on the state's public works program was the feature of the arch meeting of the Georgia Section. This was given by Harold Friedman, consultant to the Public Works Panel of Georgia's gricultural and Industrial Board. Mr. Friedman outlined the bjectives of the Panel, which are to stimulate interest and co- rdination of effort by local, state, and national agencies in planning r the development of the state.

Kansas City Section

The Section's first meeting of the year took place on February 9. ollowing a dinner and business discussion, the "Recreation tars" of the City Welfare Department, a trained chorus, enter- ined with a group of songs. The technical program consisted f a talk by "Zan" Maitland, president of the Kansas City Bridge ompany, who gave an informative address on the joint operations of the Metcalfe Construction Company, the Hamilton Construction Company, and the Kansas City Bridge Company in the construction of bases and relay stations at 100-mile intervals along the Alaska Highway. Mr. Maitland concluded the program by showing a beautiful motion picture that he had made on one of his many trips along the highway.

Kentucky Section

Members of the Kentucky Section met at Lexington on January 26 for a luncheon and technical program. Guest of honor and speaker was M. R. Clements, director of the Southern Building Codes Congress at Birmingham, Ala., who developed the subject that a modern uniform building code is essential to the engineers of Kentucky. He recommended that a uniform code be adopted by all Southern cities and that the code be kept up to date.

Lehigh Valley Section

On March 12 Ario Wear addressed a meeting of the Section on "The Wild Creek and Penn Forest Water Supply Developments." Mr. Wear is director of parks and public property for the city of Bethlehem, Pa. A program of moving pictures, showing the moving of an entire aluminum plant out of France, concluded the session. The speaker at the April meeting was Capt. L. M. Fraivillig, whose topic was "An Engineer with the American Military Government."

Los Angeles Section

Navy uniforms gave color to the March meeting of the Section, which was attended by a number of V-12 students from the University of Southern California and California Institute of Technology. During the evening A. M. Rawn, retiring Director for District 11, introduced John H. Gardiner, of Tucson, Ariz., the new Society Director for the District. The speaker of the evening—James Bone, manager of the industrial department of the Los Angeles Chamber of Commerce—discussed the postwar problems confronting the steel industry on the Pacific Coast and emphasized the vital concern of the industrial West in the continuance of steel fabrication.

Louisiana Section

Part of the March meeting of the Section—held in New Orleans on the 29th—was devoted to business discussion. A talk by A. B. Paterson on "The Outlook for the Postwar Economic Development of Louisiana" comprised the technical program.

Maryland Section

On March 22 members of the Maryland Section heard Rear Admiral John J. Manning discuss the rôle of the Seabees in the Normandy invasion. Admiral Manning painted a graphic picture of the invasion, stating that the work of the Seabees included the making of 147 concrete caissons that were towed across the Channel and sunk into position on the French coast. These piers and beachheads were used for 147 days until the weather became untenable. During this period they aided in the landing of 10,000 men a day, a total of 880,000 motor vehicles, and millions of tons of material. The caissons, of course, were only part of the numberless contributions of this engineering group to the success of the invasion. A moving picture of salient features of the invasion concluded the technical program.

Metropolitan Section

Admiral Manning was also the principal speaker at the March 21 meeting of the Metropolitan Section. On this occasion he discussed the activities of the Bureau of Yards and Docks and described the work of the Seabees in the building of floating drydocks. His talk was followed by the showing of a motion picture on the construction of a floating harbor.

Michigan Section

A lecture on "Wartime Activities of the F.B.I." was enthusiastically received at the February 28th meeting of the Michigan Section. This was given by R. A. Guerin, special agent in charge of the Detroit office of the Bureau. Starting with a force of 400 agents in 1930, he stated, the Bureau now has a personnel of over 4,500. A symposium on the recreational needs of Detroit and its metropolitan area was presented at the March meeting. The principal participants were Harold M. Owen, secretary of the Huron-Clinton Metropolitan Authority, with headquarters in Detroit, and C. J. Tinker, of the Michigan State Department of

Conservation. The former outlined what is being done by his organization to meet the recreational needs of the Detroit area while Mr. Tinker spoke on the work of the Department of Conservation to effect the same result, pointing out that the Department cooperates very effectively with the Huron-Clinton Metropolitan Authority. In closing, he showed a colored motion picture of the Porcupine Mountain Area.

New Mexico Section

A joint meeting of the New Mexico Section and the Albuquerque Committee for Economic Development took place in Albuquerque on March 28. During the evening a paper, prepared for the occasion by Mark Owen, chairman of the Society's Committee on Postwar Construction, was read and discussed. Then Roy Smith, director of the Tenth Federal Reserve Region for the Committee on Economic Development at Kansas City, spoke. Mr. Smith briefly reviewed the methods used by the Committee and discussed the success of the organization's efforts, concluding his talk with the showing of a film entitled "Mobilizing Main Street." Later in the evening members of the Student Chapter at the University of New Mexico served refreshments to the group.

Northeastern Section

The March meeting of the Northeastern Section was held in Boston on the 28th. A talk by Commdr. George E. Wells, who is currently public works officer at Portland, Me., comprised the technical program. Commander Wells discussed his experiences with a construction battalion in the South Pacific during the early days of the war. Supplementing his talk with motion pictures, he described the construction of the airfield, seaplane ramps, highway, and buildings on a small Pacific island.

Northwestern Section

At the March meeting of the Section, which took place at the University of Minnesota on the 12th, the principal speaker was P. W. Riedesel, public health engineer for the Minnesota State Department of Health. Mr. Riedesel spoke on water-pollution control and discussed the legislation now before the Minnesota State Legislature that would enable such control. Participants in the round-table discussion of Mr. Riedesel's talk were President Paul, George M. Shepard, George J. Schroepfer, W. S. Olson, Bernard Blum, C. W. Britzius, H. S. Loeffler, H. L. Wilson, H. C. Leibee, J. A. Estabrook, and F. W. Blaisdell. At the April 2 meeting members of the Section heard George M. Schaller, construction counselor of St. Paul, describe the construction of the Farragut Naval Training Station, of which he was project manager.

Oregon Section

The technical program at the February meeting of the Oregon Section consisted of an illustrated lecture on the Alaska Highway, the speaker being N. F. McCoy. Mr. McCoy, who is principal highway engineer for the Public Roads Administration, covered the reasons for building the highway, the selection of the route, methods of location and construction, and a description of the finished road.

Philadelphia Section

"Remarkable Developments in Reinforced Concrete Design and Construction in South America" were discussed by Arthur J. Boase at the March meeting of the Philadelphia Section. Mr. Boase, who is manager of the Structural and Technical Bureau of the Portland Cement Association, spent some months in Brazil, Argentina, and Uruguay, studying methods of reinforced building design and construction. He found these countries enjoying an unprecedented building boom, and everywhere he was impressed by unique developments in concrete design and construction. Following Mr. Boase's talk, interesting moving pictures of buildings under construction and building methods were shown.

Pittsburgh Section

The Pittsburgh Section held a joint meeting with the Pittsburgh chapter of the Pennsylvania Society of Professional Engineers on March 22. John J. Paine, director from Pennsylvania for the latter group, spoke, as did Society Director C. F. Goodrich. The principal address, entitled "A Trip Through South America," was given by William A. Leech, Jr., of the Koppers Company.

Providence Section

On March 14 members of the Providence Section heard Prof. Henry G. Houghton, head of the department of meteorology at Massachusetts Institute of Technology, give an illustrated lectu on the topic, "Meteorology at Home and at War." After a bri lesson in reading a weather map, Professor Houghton proceeded t discuss the present aspects of meteorology, laying particular stre on the part it has played in the present war. He then describe by means of the weather maps, the reasons for the course taken b the New England hurricanes of 1938 and 1944, and closed his ta with a plea for the peacetime employment of some of the meteo ologists now being trained by the Armed Forces.

Rochester Section

The speaker at the March meeting of the Section was William H Roberts, chairman of the Board of Standards and Appeals of th State Labor Department. Mr. Roberts gave an interesting an timely talk on the duties of his Board as well as excellent advice t those who must appear at the Board's hearings.

Sacramento Section

During March John J. Hamlyn, counsel for the McClatch Company, addressed one of the Section's luncheon meetings o "Developments in Radio Broadcasting." A week later the sub ject, "Taxation of Commercial Air Lines," was discussed by A. G Mott, director of the Valuation Division of the California Board o Equalization. Mr. Mott described the problems of multip taxation of air lines by different states, and the current efforts b various agencies and organizations to find an equitable solutio Sound films on the rôle of engineers in the war were presented at th last meeting of the month.

St. Louis Section

At the meeting held on February 26 Society Director H. F Thomson reported on the January meeting of the Board of Dire tion, and Alroy S. Phillips spoke briefly, asking for support for th proposed new constitution for the state of Missouri. The showin of interesting motion pictures on wartime uses of rubber and th making of synthetic rubber concluded the technical progra These were shown and explained by W. B. Schmidt, of the Fir stone Tire and Rubber Company. There was a special lunche meeting of the Section on March 5 to hear Howard F. Peckwort assistant to the Secretary of the Society, discuss the type of activ ties the Society is currently engaged in.

San Francisco Section

The first regular meeting of the 1945 season took place o February 20. After opening the meeting, Past-President T. J Corwin, Jr., turned the gavel over to the new president, George D Whittle. Several committee reports were presented during th business session, and Director F. C. Scobey gave a résumé of th high lights of the January meeting of the Society. Then Henry Thackwell and Walter N. Frickstad commented briefly on colle tive bargaining groups. The technical program consisted of a illustrated talk by T. M. Price, vice-president of the Kaiser Com pany, on the Fontana Steel Plant.

The feature of the January meeting of the Junior Forum was talk on "Geophysical Exploration in the Middle East," which w given by Edward N. Frisius, a member of the Forum. The top of general discussion was "Possible Aims and Purposes of a Colle tive Bargaining Group."

Spokane Section

Part of the January meeting of the Spokane Section was devote to a discussion of the topic of coordinate surveys and mappin The speaker of the evening—R. E. Tobin, of Gonzaga University presented a paper on "The Distribution of Water Pressures i Reinforced Concrete Tanks," which gave the solution of wate pressures distributed between the cantilever and ring element based on the theory of deflections using ten simultaneous equation A large group turned out for the March 15th dinner meeting, whe President J. C. Stevens was guest of honor and speaker. M Stevens spoke on Society activities of interest at this time, empha sizing particularly the work of certain Society committees.

Tacoma Section

Much of the March dinner meeting of the Section was devoted t business discussion. The Program Committee had arranged f the showing of an interesting series of war films, showing the trai ing of engineer forces as well as actual combat scenes. This pr gram was presented by Paul Meyers, of the Fort Lewis Post Eng neers, and R. W. Peters and L. H. Hill, of the Fort Lewis Turnin Film Library.

ITEMS OF INTEREST

About Engineers and Engineering

Hydrographic Records Assist in Rhine Crossing

A Release from the Office of the Chief of Engineers, Washington, D.C.

WHILE District and Division Engineers
the War Department here at home have
en watchfully guarding against the an-
al rises on the Ohio and Mississippi
ers, Army Engineers in the Rhine valley
ve been waging a grim battle of intel-
ence against the German general staff.

Since the tenth of January of this year,
ilian specialists of the U. S. Engineer
epartment and other federal agencies
ve operated with Engineer and Air Force
icers a flood prediction service along the
ine, providing general river-stage pre-
tions and reports on icing and flooding
nditions for the Rhine River and its tribu-
ies from Nijmegen, near the mouth, all
e way up to Basel at the Swiss border.

ce the 16th of March the powerful voice
Radio Luxembourg has broadcast twice
day 48-hour advance predictions of
er stages to all Army, Corps, and Divi-
n commands conducting the "cross-the-
ine" offensive.

How important this river intelligence
s been in the current operations may be
thered from the introduction to the first
ydrologic Bulletin issued about the
vice. This report pointed out: "The
e of various types of amphibious equip-
nt, floating craft, ponton bridging,
ble ferries, and temporary fixed bridges
the crossing of the Rhine will require
ecial precautions to be taken during
ods to minimize interruption of service
d avoid loss of equipment: Immedi-
ely preceding and after initial crossing
erations, reliable predictions of stages
ng reaches of the river involved will be
al to security of the crossing."

Mr. Gail Hathaway, M. Am. Soc. C.E.,
g-time Head Engineer of the Reservoir
eration and Hydrology Section, Civil
orks Division, Office of the Chief of En-
eers, set up the Flood Prediction Ser-
e, drawing from all resources available
the Engineer Department in its long
dy of the world's major waterways.
ajor A. L. Cochrane, Assoc. M. Am. Soc.
E., a former assistant to Mr. Hathaway,
d prepared preliminary data.

As early as the last day of October 1944,
aterial culled from the libraries of the
ississippi River Commission, U.S. Engi-
er Waterways Experiment Station at
cksburg, Miss., was made available to
r. Hathaway, including German atlases
1872 and 1889, which gave widths and
pths of the Rhine at a number of cross
tions. The flood data from 13 selected
ars, giving flood stages for all gages on
e Rhine and the time of travel of flood
sts down river from Lake Constance to
e Dutch border, plus flood data for the
er Rhine in Holland, including that for
e greatest flood on record, were obtained
m a private library. Other material
otostated in the District Engineer office
in Vicksburg included 24 sheets of hydrographs showing annual river stages at half a dozen critical points; an article on cutoffs; tabulations showing the zero elevations of existing gages; 12 precipitation charts giving detailed information about rainfall at various points along the Rhine; and a temperature chart showing the variation in temperature for a selected year. Flood stages in the Meuse River, obtained from a Dutch source, were also included in the shipment. From German reports, additional information was translated regarding ice, its time of occurrence, and difficulties reported by commercial navigation at such times. The data on ice occurrence was given special attention because of its direct connection with ponton bridge planning.

VERSUS THE GERMAN GENERAL STAFF

Adding emphasis to the battle of intelligence was the American Engineers' knowledge of a report prepared for the German Army General Staff, entitled "Das Rheinstromgebiet," or "Artificial Flood Waves on the Rhine." This report outlined the possibilities of creating artificial floods by operation of the power dams on the upper Rhine, and estimated that flood waves could be thus created which would carry away ponton bridges "probably as far as Strassburg."

The report cited that "flood waves of a completely catastrophic effect can be produced by blasting the Rhine dams in such a way that at the time of the entry of the flood wave into the upper part of each pond the next downstream dam is blasted." The German General Staff was even advised that, "To avoid disadvantage to German forces, destructive waves of small scope, which can be produced by suitable regulation of the dams, could impose considerable disadvantages on the Allied conduct of war." Anticipating what is now a *fait accompli*, the report suggested that, "A military crossing of the upper Rhine, in case the existing bridges are blasted or rendered useless, will meet considerable difficulties at most places because of the steep banks, the great water depths or strong current (where the depth is less), and the occasional rocky river bed."

Now that the Rhine is safely crossed, some details of the tremendous advance planning which went into the crossing can be released. Artificial flooding is still possible, though no longer very probable; but during the next few weeks, while temporary fixed bridges are built by the Engineers to replace their tactical ponton bridges, natural flash floods could still create havoc unless sufficient advance warning is given. The Flood Prediction Service will continue in operation to warn tactical commands of spring or summer rises along the Rhine or its tributaries which might affect military operations.

"This is one more example," says Maj. Gen. Eugene Reybold, M. Am. Soc. C.E., Chief of Engineers, "of how technical experience acquired during the years of peace is being used to hasten victory."

Pamphlet on Rehabilitation of Veterans

REALIZING that the rehabilitation of war veterans is one of the major problems facing the country today, the Allis-Chalmers Manufacturing Company has issued a guide for foremen, entitled "You and the Returning Veteran." This manual, which is one of the first of its kind, was prepared with the assistance of the Wisconsin Society for Mental Hygiene. This assistance, plus the company's own experience in employing, to date, more than 1,100 veterans of the war, makes the manual a unique contribution to the veterans' rehabilitation program.

Copies may be obtained without cost from Charles W. Granger, Public Relations Editor, Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

Athens Institute Seeks American Aid

ALL SCIENTIFIC technical work in Greece is centered in the Athens Institute of Technology. All research work in the field and most of the testing laboratories are also centered there. In view of its unique position, the Institute is expected to be at the forefront in dealing with the technical problems of rehabilitation and reconstruction which face Greece at this time and will face her in the years to come. The Institute must carry on the technical education of Greek students, which was its task before the war. It must also greatly increase its facilities—educational, research, and laboratory—in order to reeducate and orient Greek engineers in new techniques and methods discovered and practiced in the past five years.

Like most of Greece's educational institutions, the Institute of Technology suffered much during the war. Ever since the attack of Italy on Greece in October 1940, the government was compelled to use the Institute as a military hospital. When the Nazis occupied Athens in April 1941, the buildings of the Institute were still filled with wounded Greek soldiers. When a month later the invaders attacked Crete and needed additional hospital facilities, they expelled the wounded Greek soldiers and used the Institute's buildings as a German army hospital. A little later the Italians fell heir to the premises, and it was only at the end of 1941 that the Institute's authorities were able to recover the buildings. They then discovered that much of the furniture and part of the equipment had disappeared.

The Institute has addressed an appeal for assistance in reconditioning its facilities to American educational institutions, through the Greek Ambassador. Particular needs, in addition to financial support, are: printing facilities, technical books, educational films and slides, laboratory equipment, models (engineering), and good will.

A former professor at the Institute, Lt. Peter J. Doanides, M. Am. Soc. C.E., has been sent by the Greek Government on a technical mission to the United States. Among other duties in this country, he is charged with carrying this appeal for assistance. American Friends of Greece, Inc., have indorsed this program and given it their support. To secure further information, or to make offers of equipment or supplies, address Lt. Doanides at the Greek Consulate, Radio City, New York, N.Y.

Special Symposium on Parking Issued

ALL concerned with city planning and the movement of traffic will be interested in the February number of *Traffic Engineering*, a special issue devoted to parking. In a recent survey of *Traffic Engineering* readers, parking was adjudged the number one subject of interest as well as the primary problem facing our cities today. Thus it was decided to devote a whole issue to this important subject.

Copies of the February number are available upon application to the Institute of Traffic Engineers, 60 John Street, New York 7, N.Y., at a cost of 20 cents a single copy. The subscription price is $1.50 a year.

Engineering College Enrollment

OF INTEREST is a current report to the Engineers' Council for Professional Development, made by its Committee on Engineering Schools, under the chairmanship of D. B. Prentice. Especially timely are the comments regarding the present use of the facilities of technical institutions.

Enlarging on this subject, the Committee notes that "enrollments at engineering colleges are very low, not over a third, counting freshmen, of five years ago. Nearly 60% of the students are freshmen, so that above this class present enrollment is approximately 20% of prewar, with senior class registration down to one-sixth. In spite of this condition, most engineering schools are carrying on their programs with little reduction from normal. Smaller classes will more than offset other disadvantages, so that graduates of these years, it is believed, will be as well trained as under ordinary conditions."

This condition is significant. Most engineers will agree that it is important to maintain our professional educational system. It should be available to serve the many interested young men who will be released from the armed forces, and also to provide opportunities for filling the ranks of young engineers depleted as a result of wartime interference with education.

N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

"TOMMY Tusser could have quipped, 'Except wind stands as never it stood, it is a *nil* wind turns none *too* good' without more anonymity to those who habitually misquote him. But we made the wind stand for the Flire brothers for two reasons, so that they could demonstrate the quickest way home in a wind, and so that you could figure the speed of the wind."

"So that I couldn't, you mean," complained Joe Kerr. "After laying out the map for a graphical solution, I found I needed the wind speed first, not last. But I got a good start from the component vector equations:

$$\frac{dy}{dt} = \frac{-vy}{\sqrt{x^2 + y^2}} \text{ and } \frac{dx}{dt} = kv - \frac{vx}{\sqrt{x^2 + y^2}}$$

which led in only 5 frantic nights to $x = \frac{y}{2}\left[\left(\frac{a}{y}\right)^k - \left(\frac{y}{a}\right)^k\right]$ for Hi Flire's trail in terms of a (=60), the direct distance, and k, the unknown ratio of wind to air speed. But I couldn't integrate time along that curve."

"If possible, that would be the hard way," suggested Cal Klater. "Joe's equations do lead to:

$$\frac{dt}{dy} = -\frac{1}{2v}\left[\left(\frac{a}{y}\right)^k + \left(\frac{y}{a}\right)^k\right] = t$$

$$\frac{1}{2v}\left[\frac{2a}{1 - k^2} - \frac{y}{1 - k}\left(\frac{a}{y}\right)^k - \frac{y}{1 + k}\left(\frac{y}{a}\right)^k\right]$$

and, when $y = 0$, the total time for Hi, $T_H = \frac{a}{v(1 - k^2)}$. Obviously, Lo's time was $T_L = \frac{a}{v\sqrt{1 - k^2}}$, so we can write:

$$\frac{60}{100\sqrt{1 - k^2}} + \frac{2}{3} \doteq \frac{60}{100(1 - k^2)}$$

and find $k = 0.8$. So the zephyr zipped at 80 miles per hr."

"Agreed," said Ken Bridgewater, "but you don't need the equation of Hi's trail if you use polar coordinates. I'll bet Joe and Cal ruined a ream of rationed foolscap, but my method fits on a calling card (Fig. 1). Just for comparison, I appended the polar equation of the curve."

"Bravo!" exclaimed the Professor, as if he meant it. "You two have done everything but name the curve."

"It's so like the Pursuit Curve, $x = \frac{y}{2\sqrt{1 - k^2}}\left[\left(\frac{a}{y}\right)^k - \left(\frac{y}{a}\right)^k\right]$, that we might call it a 'hypersuit' curve," suggested Dick, "except that a fixed object can't be pursued."

"Or a 'hyperabola,'" countered the P fessor. "The simplest general form $x + \sqrt{x^2 + y^2} = Cy^{1-k}$, which is a para ola when $k = 1$.

"Incidentally, the curve may be a goo gamble in navigation. It wins more th it loses, except wind stands as never stood. I've marked (Fig. 1) the positio of Hi and Lo every 10 min. For the fir 40 min, Hi led the race and a rando change in the wind would destroy Lo advantage in azimuth.

"That suggests a sequel. Suppose th ponent wind became suddenly levant du ing the race, and the brothers ran a de heat. How far off course was Hi whe the wind veered?"

MATHEMATICS ACCOMPANYING FIG. 1

$$-\frac{dr}{dt} = v - kv\cos\theta$$

$$-\frac{rd\theta}{dt} = kv\sin\theta$$

$$1 - k^2 \equiv (1 - k\cos\theta)(1 + k\cos\theta) - k^2\sin^2\theta$$

$$= \frac{-dr}{vdt}(1 + k\cos\theta) + \frac{rd\theta}{vdt}k\sin\theta$$

$$v(1 - k^2)dt = -dr - k(\cos\theta dr - r\sin\theta d\theta)$$

$$v(1 - k^2)t = -r - kr\cos\theta + c$$

When $t = 0, \theta = \pi/2, r = a = c$

$$t = \frac{a - r(1 + k\cos\theta)}{v(1 - k^2)}$$

When $r = 0$, $T_H = \frac{a}{v(1 - k^2)}$

$$r = a\sin\theta\sqrt[k]{ctn\frac{\theta}{2}}$$

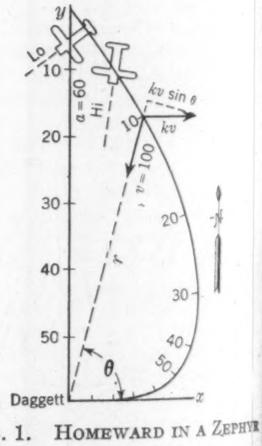


FIG. 1. HOMEWARD IN A ZEPHY

[The Cal Klaters were: Claude W. W (who used the polar method), Ad L. P (Grover H. Wilsey, who answered rid with riddle), Richard Jenney (who co piled many analogies between pursuit a hypersuit curves), O'Kay (Otto H. S. Ko who wondered how much time Lo would l turning into the wind to land) and P Seide. Also acknowledged are excell

utions to the February problem from Kay and Neare Lee Wright II (Allyn P. rsley), which barely missed an early dline.]

Honorable Service Button Worn by Veterans

MORE than a million veterans of the med forces are now entitled to wear the norable Service Button which is issued each individual on his discharge from Army, Navy, Marine Corps, and ast Guard.

While this button should entitle its arer to the respect of Americans every- ere, the War Department is frequently ormed that the public does not gen- ally recognize the meaning of the em- em. Veterans with long combat service erseas, now returned to civilian life, ve the unpleasant experience of being allenged for their failure to appear in iform. Their badge of honorable service s not been recognized.

ONORABLE SERVICE BUTTON ISSUED TO VETERANS BY ALL SERVICES

Any veteran who has lost the button iginally issued to him may obtain a plicate at cost (7 cents) by presentation his discharge certificate to the Quarter- aster Supply Officer at any post, camp, station, or by writing to the Adjutant eneral, War Department, Washington , D.C.

New in Education

~*Welding Library*

A SPECIAL welding library, comprising a mprehensive collection of books, pam- hlets, and magazines on the various pects of welding, has been established at e Cooper Union Library, Cooper uare, with the assistance of a fund pro- ded by the James F. Lincoln Arc Weld- g Foundation, it is announced by Dan . King, librarian. The foundation is voted to encouraging scientific research aid in the development of the welding dustry.

The collection, which will be kept up to te through the addition of newly pub- hed books as well as current issues of elding journals, has been placed with the rary's already large assortment of books engineering. Although the Cooper nion Library is used by students of The oper Union, it is a public library, and the new welding collection, like the rest of its varied resources in both technical and general fields, is available for use by anyone interested.

NEWS OF ENGINEERS

Personal Items About Society Members

ARTHUR R. C. MARKL, until lately assistant mechanical engineer for the M. W. Kellogg Company, of New York, N.Y., has accepted the position of chief research engineer for Tube Turns, with headquarters in Louisville, Ky.

WILLIAM M. WIESENBERG, of Brooklyn, N.Y., is the recipient of the War Department's Emblem for Exceptional Civilian Service for his wartime work as chief engineer of the Securities and Safety Branch of the Office of the Chief of Ordnance in Chicago, Ill.

HANS KRAMER, brigadier general, Corps of Engineers, U.S. Army, has been assigned as military assistant to **BRIG. GEN. MAX TYLER**, president of the Mississippi River Commission. He will be stationed at the headquarters of the Commission in Vicksburg. General Kramer recently served as chief engineer for the Central Pacific Area, but was forced to return to this country because of illness contracted there.

JACK R. CHARLES has been promoted from the position of chief engineer for Magnesium Elektron Ltd., Manchester, England, to that of general manager of the organization.

WILSON V. BINGER, who was commissioned a second lieutenant in the Corps of Engineers, U.S. Army, last August, now has an overseas assignment. He will be glad to have his friends write him at the Office of Military Attache, APO 787, c/o Postmaster, New York City.

HOWARD H. STURDY, lieutenant colonel, U. S. Army, was recently awarded the Bronze Star Medal for "meritorious achievement at Hollandia, Dutch New Guinea, and in connection with military operations against the enemy at San Fabian, Luzon, Philippine Islands." The citation further states that, "His exceptional energy, industry, and superior ability contributed materially to the successful completion of . . . the operation." Before entering the Army in June 1942 as first lieutenant, Colonel Sturdy was an engineer for the Dravo Corporation, in Pittsburgh, Pa.

J. LLOYD BARRON resigned recently as director of the Division of Sanitation of the Nassau County (New York) Department of Health to become sanitary engineer for the National Biscuit Company, with offices at 449 West 14th Street, New York City. His work will include sanitary supervision of the company's milling and manufacturing plants throughout the United States. Mr. Barron will be succeeded as director of the Division of Sanitation by **ARTHUR H. HERBERGER**, formerly assistant sanitary engineer for the Nassau County Health Department.

WILLIAM HENRY SMITH now has the temporary rank of rear admiral in the Civil Engineer Corps of the U.S. Navy. He is currently head of the Planning and Design Department and chief planning officer of the Bureau of Yards and Docks. Other Society members in the Civil Engineer Corps who have recently been promoted include **PAUL J. HALLORAN** and **WILLIAM O. HILTABIDLE**, both from the rank of captain to the temporary rank of commodore. The latter is a recent recipient of the Bronze Star Medal for his work as officer-in-charge of a naval construction brigade.

SAMUEL SAMSON, who has been engaged in engineering work at the Carlsbad (N. Mex.) Army Air Field since the original survey for the field was made, has been granted a leave of absence by the engineers at the post to enter private practice. Mr. Samson will be associated with Steele Brothers, Nebraska contracting firm, in the capacity of New Mexico state representative, with headquarters in Carlsbad. Operating throughout the state, the firm proposes to supply contractors with street and highway building materials.

BREHON B. SOMERVELL, commander of the Army Service Forces, has been made a full general in the U. S. Army. He will hold the permanent rank of major general in the regular Army.

DUGALD C. JACKSON was honored on the recent occasion of his eightieth birthday with a testimonial dinner, held in Boston and sponsored by many well-known engineers. Karl T. Compton, president of Massachusetts Institute of Technology, presided. Long prominent as a consultant in the field of electrical engineering, Dr. Jackson was on the staff of the Massachusetts Institute of Technology from 1907 until his retirement in 1935.

THEODORE B. JENSON, of Minneapolis, Minn., has been promoted from the rank of major in the Corps of Engineers, U.S. Army, to that of lieutenant colonel. He is at the headquarters of the South Pacific Base Command, where he is assistant executive officer of the Engineer Section as well as officer-in-charge of all construction projects within the command.

FRANK H. MALLEY has resigned as director of the Buffalo (N.Y.) City Planning Commission in order to accept the newly created post of planning director for the Providence (R.I.) City Plan Commission. Prior to going to Buffalo last July Mr. Malley was for fourteen years chief engineer and executive director of the Boston City Planning Board.

CARROLL A. FARWELL was elected president of the Boston Society of Civil Engineers at the 97th annual meeting of that organization, held on March 21. Mr. Farwell is a member of the Boston firm of Fay, Spofford and Thorndike.

WILLIAM C. BOWERS, lieutenant commander, CEC, U.S. Navy, who recently returned from two years in the Southwest Pacific with the Seabees, has been appointed design superintendent in the public works department of the Eighth Naval District, with headquarters in New Orleans, La.

Robert O. Jameson, formerly negotiator for the Southwestern Division of the Corps of Engineers at Dallas, Tex., is now associated with the Dallas architectural and engineering firm of Thomas, Jameson, and Merrill.

Forrest S. Crocker, until lately general superintendent of the Spencer B. Lane Company, Spokane, Wash., has become connected with the firm of Crocker and Ryan of Denver, Colo. The firm name will continue to be Crocker and Ryan.

F. M. Weakley has accepted a position at the ordnance Plant, Camden, Ark. He was previously construction engineer for the Public Buildings Administration at Dallas, Tex.

Frank E. Richardson has severed his connection as manager of the Pan-American Pipe Line Company at Houston, Tex., and moved to Kansas City, Mo., where he will be a partner in the newly organized firm of Foreman, Richardson, and Baird.

Malcolm Elliott and Maybin H. Wilson, both colonels, Corps of Engineers, U.S. Army, are recent recipients of the Legion of Merit. The citation accompanying Colonel Elliott's award reads: "In addition to the normal duties as division engineer [Upper Mississippi Valley Division], Colonel Elliott was charged with carrying out a tremendous building program to house the increased Army and to construct airfields for the expanded Air Force. . . ." The award was made to Colonel Wilson "for meritorious service as commanding officer of the 177th Engineer Regiment, which accomplished a huge construction project at Fort Richardson, Alaska, from October 1942 until December 1944. . . ."

Burnett P. McWhorter, who has been on the staff of the Public Roads Administration since 1934, will be division engineer in charge of the PRA office at Montgomery, Ala., directing federal highway activity in five Southern states. Until lately Mr. McWhorter was senior highway engineer for the Administration at Richmond, Va.

Charles A. Reed is now assistant city engineer and assistant superintendent of streets for Oakland, Calif., the position representing a promotion from that of street improvement engineer.

Cherry L. Emerson, vice-president and chief engineer of Robert and Company, Atlanta engineers, has been appointed dean of engineering at the Georgia School of Technology. Another member of the Society, Lt. Col. Thomas Evans, will also be on the staff there—in the capacity of professor of civil engineering. Before entering the Army Colonel Evans had been in the engineering department at the University of Virginia.

Frank Kerekes, professor of structural engineering at Iowa State College, is a recent recipient of the John Dunlap Award of the Iowa Engineering Society for his work as chairman of the state building code committee. The award is named for the former Secretary of the American Society of Civil Engineers, who had previously served in the presidency and other offices of the Iowa Engineering Society.

Albert A. Miller was elected president of the American Railway Engineering Association early in March. He is chief engineer of maintenance of way and structures for the Missouri Pacific Railroad. James B. Akers, assistant chief engineer for the Southern Railway System, will be first vice-president.

Kathleen F. Lux is now a lieutenant (jg) in the Civil Engineer Corps of the U.S. Navy, the only woman officer in the Corps since it was established in 1867. Miss Lux is stationed at the Bureau of Yards and Docks, where she is an assistant in the office of the director of the construction department.

Harold N. Davidson, engineering assistant for the Stone and Webster Engineering Corporation, has been transferred from Knoxville, Tenn., to Chattanooga.

Irwin T. Johnson has been promoted from the rank of first lieutenant in the Corps of Engineers, U.S. Army, to that of captain. At present he is stationed at Fort Lewis, Wash.

Jack S. Barrish, captain, Corps of Engineers, U.S. Army, is in the Philippines now, having been assigned to the new U.S. Engineer District there.

John W. Frink was recently transferred from the Tennessee Valley Authority, for which he was assistant geologist at Hales Bar Dam, to the U.S. Bureau of Reclamation. He will be located near Sacramento, Calif.

J. O. Joerns, until lately in the office of the U.S. Geological Survey at Santa Fe, N.Mex., has been transferred to Knoxville, Tenn.

Marion E. Weatherby, Jr., is now a colonel in the Corps of Engineers, U.S. Army, the rank representing a recent promotion from that of lieutenant colonel.

Cecil E. Pearce has resigned as head civil and hydraulic design engineer for the second Nisqually power development at Tacoma, Wash., in order to become hydraulic engineer for the Ebasco Services, Inc., of New York City.

Paul A. Jones, construction engineer for the U.S. Bureau of Reclamation, has been assigned to the Hungry Horse Dam project at Kalispell, Mont. He was formerly located at Terry, Mont.

John C. King, Jr., major, Corps of Engineers, U.S. Army, has just been evacuated as a casualty from the Philippines. At present he is a patient in Moore General Hospital, Swannanoa, N.C., where he will be glad to hear from his friends.

DECEASED

Robert Picket Carr (Assoc. M. '29) consulting engineer of Oruro, Bolivia, died in Lima, Peru, on February 23, 1945. Mr. Carr, who was 48, had spent most of his career in South America, having gone there soon after his graduation from college in 1921. He had been with the Braden Cop-
per Company at Rancagua, Chile;
Cia Hildro Electrica-Volcan, of Santia
Chile; assistant to the president of
Constructora del Pacifico at Santia
and mining engineer for the Internatio
Machinery Company at Oruro, Boliv
For the past ten years he had maintai
a consulting practice in Oruro.

Ramon Ramos Casellas (M. '27)
retary of the Association of Sugar P
ducers of Puerto Rico, San Juan, Puer
Rico, died on August 3, 1944, at the age
63. Born in Puerto Rico, Mr. Casel
was educated in the United States, grad
ating from Rensselaer Polytechnic Ins
tute in 1905. Returning home, he serve
as city engineer of Arecibo from 1905
1915, and from the latter year to 1920
was connected with the Insular Depar
ment of the Interior. From 1920 to 19
he was general manager for several priva
sugar concerns, and from the latter ye
on served as secretary of the Associati
of Sugar Producers of Puerto Rico.

Walter Sherman Lyle Cleverdo
(M. '21) who retired in 1938 as an ass
ciate professor of sanitary engineeri
and supervisor of property at New Yo
University, died at his home in Bron
ville, N.Y., on March 25, 1945. His a
was 67. Before joining the New Yo
University faculty in 1918, Mr. Cleverdo
was for several years designer and assista
engineer for the New York City Board
Water Supply, Gas and Electricity.

James Roger Crocker (Assoc. M. '1
district manager for the Permutit Co
pany in Kansas City, Mo., died on Mar
29, 1945. Mr. Crocker, who was 69, ha
been with the Permutit Company for ov
thirty years. During this period he w
chief engineer in the New York office b
fore going to Kansas City as district ma
ager. Earlier in his career (1902 to 190
he was with the Acker Process Compan
of Niagara Falls, N.Y., and from 1906
1915 he was with the McDonald Electr
lytic Company, of New York.

Bernard Reuvelt Crowley (Asso
M. '41) resident engineer for the Tex
State Highway Department at Benha
Tex., died recently. Mr. Crowley, wh
was 39, had spent his entire career wi
the Texas State Highway Departme
with which he became connected in 19
He had been chief of survey parties, assis
ant resident engineer, and (since 19
resident engineer. He was an alumnus
the Texas Agricultural and Mechani
College.

Albert Harlow Dakin (M. '03)
tired engineer of New York, N.Y., died
March 14, 1945, at the age of 78.
Dakin spent most of his career in railro
work, having been terminal engineer
the Lehigh Valley Railroad in New Yo
and for the Chicago, Milwaukee and
Paul Railroad. At the time of his retir
ment six years ago he was with the Ce
tral Railroad of New Jersey.

Ernest Buel Day (Assoc. M. '13)
signing engineer for the Hudson and Ma
hattan Railroad, New York, N.Y., died
February 28, 1945, at the age of 60. Fro
1901 to 1906 Mr. Day was draftsman
the Manhattan Railway Company,

Lithographed on stone by Edward A. Wilson

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from 1906 to 1909 structural draftsman for the Building Bureau of the New York City Board of Education. Since 1909 he had been with the Hudson and Manhattan Railroad Company—from 1921 on in the capacity of designing engineer in charge of all design.

HERBERT MCMILLEN DIBERT (M. '43) secretary-treasurer and general sales manager of W. and L. E. Gurley, of Troy, N.Y., died at his home in that city on April 7, 1945. From 1908 to 1912 Mr. Dibert taught at Rensselaer Polytechnic Institute, his alma mater, and at the University of Pennsylvania. Since the latter year he had been connected with W. and L. E. Gurley, manufacturers of mathematical instruments.

WALTER GOTTLIEB FEDERLEIN (Assoc. M. '09) construction superintendent for the New York State Mental Hygiene Department, died in New York City on March 11, 1945, at the age of 64. From 1910 to 1919 Mr. Federlein, was engaged on subway construction in New York; from 1921 to 1923, engineer for the Underpinning and Foundation Company, of New York; from 1923 to 1925, resident engineer for Fuller and McClintock on dam and sewer construction; and from 1926 to 1930, chief engineer for the Sexton Corporation, of Mineola, N.Y., on the construction of water and sewerage works. Later Mr. Federlein was deputy borough engineer for the Emergency Relief Bureau in the Bronx.

EDWARD FRY, JR. (Jun. '43) first lieutenant, Corps of Engineers, U.S. Army, was killed in action in the European area on November 23, 1944. Mr. Fry, who was 26, was an alumnus of the Texas Agricultural and Mechanical College, class of 1943.

STANLEY EUGENE GRAY (Jun. '42) first lieutenant, Air Corps, U.S. Army, was killed in action in the India-Burma area on January 17, 1945. His age was 24. Lieutenant Gray received the degree of B.S. in C.E. from Colorado State College in 1942. His home was in Bayfield, Colo.

ALBERT HOWARD HORTON (Assoc. M. '07) district engineer for the U.S. Geological Survey, Washington, D.C., died there on March 4, 1945. Mr. Horton, who was 69, had been with the U.S. Geological Survey since 1905. For most of this period he was district engineer in charge of surface-water investigations—first in the Ohio River Basin and, later, in the Middle Atlantic States, with headquarters in Washington. He had also been chief of the division of power resources of the Survey. Earlier in his career Mr. Horton was with the U.S. Deep Waterway Survey, the U.S. Lake Survey, and the U.S. Reclamation Service.

GEORGE TERRY HORTON (M. '04) president of the Chicago Bridge and Iron Company, Chicago, Ill., was fatally stricken on March 19, 1945, while driving his car. He was 71. Upon his graduation from college in 1893, Mr. Horton joined the staff of the Chicago Bridge and Iron Company, which had been founded by his father in the eighties. On the death of his father in 1912 he became president. Formerly the company built large bridges in many parts of the world, but since the outbreak of the war it has been making LSTs and floating drydocks. Mr. Horton was president of the American Welding Society in 1939 and 1940 and had served as chairman of the Chicago Plan Commission. A life trustee of Rensselaer Polytechnic Institute, his alma mater, he was the donor of four scholarships to it.

JOHN PATRICK HURLEY (M. '33) consul general, Department of State, Washington, D.C., died on December 30, 1944, at the age of 65. Mr. Hurley had been with the New York Board of Water Supply; the Brooklyn (N.Y.) Bureau of Highways; and the New York City Board of Rapid Transit. Since 1919 he had been with the U.S. Consular Service—for much of this period at Nassau in the Bahamas—as consulting engineer responsible to the Department of State in Washington. During the first World War he served overseas with the A.E.F., having the rank of captain.

HENRY JAMES KESNER (M. '27) professor of civil engineering at the University of Nebraska, Lincoln, Nebr., died there on February 10, 1945, at the age of 61. A native of Canada, Professor Kesner was educated in this country and spent his professional career here. He taught, successively, at the University of Minnesota, University of California, Purdue University, and Armour Institute of Technology, and since 1923 he had been at the University of Nebraska. He was responsible for the design of numerous bridges in Indiana, Illinois, and Colorado, and was the author of many papers on technical subjects.

HENRY VINCENT MACKSEY (M. '0 retired civil engineer, died at his home Brookline, Mass., on February 14, 194 at the age of 84. Mr. Macksey, w maintained a consulting practice in Bo ton at one time, had done engineering wo in South and Central America and Cub Later he served as superintendent streets for the city of Boston, and fro 1915 to 1920 he was superintendent public works for Woburn, Mass. In th latter year he went to Framingham, Mas in a similar capacity, remaining there unt 1929 when he returned to Woburn. H retired in 1932.

WILLIAM HENRY MYHAND (Assoc. M '30) of New Orleans, La., died in Hono lulu, Hawaii, on October 26, 1944. Mr Myhand, who was 54, had gone to Hawa as a civilian employee in the Supply De partment of the U.S. Navy Departmen Early in his career he was engaged in rai road work, and from 1922 to 1933 wa with the Louisiana Highway Commissio —successively as resident engineer o construction, assistant maintenance en gineer, and district maintenance superin tendent. During the first World War Mr Myhand served with the A.E.F. in Franc

SAMUEL GRAHAM NEILER (M. '24 senior member of the firm of Neiler, Ric and Company, Chicago, Ill., died at hi home in Oak Park, Ill., on February 2 1945, at the age of 78. Early in his caree Mr. Neiler was engaged in electric railwa work, and from 1892 to 1894 he was assist ant electrical engineer for the Chicag World's Fair. From 1895 to 1911 he was member of the consulting and designin firm of Pierce, Richardson and Neiler, an from 1911 to 1913 he was president of th organization. Since the latter year he ha been a member of the firm of Neiler, Ric and Company.

ALBERT OTIS TRUE (Assoc. M. '1 sanitary engineer for the Proximit Manufacturing Company, of Greensbor N.C., died on March 9, 1945. He w about 65. Early in his career Mr. Tr had been sanitary engineer in the Offic of the State Architect, Albany, N.Y., a later was with Hering and Fuller, of Ne York. He then became sanitary engine for the Proximity Manufacturing Co pany, where he had been for over twen years. During the first World War h served as a captain in the Corps of E gineers. Mr. True was recently elected Life Member of the Society.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From March 10, to April 9, 1945

ADDITIONS TO MEMBERSHIP

ABELARD, AARON RAYMOND (M. '45), State Mgr., Planning Survey, State Highway Dept., Box 1641, Santa Fe, N.Mex.

ABRAMOVITZ, MAURICE (Assoc. M. '45), Archt., U.S. Engr. Dept., Oak Ridge (Res., 104 Pine Rd., Norris), Tenn.

ALBERT, PAUL MCHENRY (Assoc. M. '45), Engr., Shoecraft, Drury and McNamee, 306 State Savings Bank Bldg., Ann Arbor, Mich.

ANDERSON, EWALT PERMENIO, JR. (Jun. '45), Ensign, CEC, U.S.N.R.; Care, E. P. Anderson, U.S. Bureau of Reclamation, Anderson Dam, Idaho.

ARGUEDAS, JOSE ANTONIO (Jun. '44), Asst. Engr., Compania Nacional de Guerzaylaz, Box 378, San Jose, Costa Rica.

BAILEY, EARL BELDEN (Assoc. M. '45), Chf., Materials Unit, Office, Chf. of Engrs., Room 1636 Temporary Bldg. H, Washington, D.C. (Res., 2831 North Westmoreland St., F Church, Va.)

BOARDMAN, HARRY CUTHBERT (Jun. '44), Ensig CEC, U.S.N.R.; 102 High St. Pennside, Rea ing, Pa.

BRODIE, ROBERT PEARSON (Jun. '45), w U.S.N.; 809 Roop St., Susanville, Calif.

BURDICK, EARL KIRKWOOD (Assoc. M. '45), C Engr., Public Works Office, Naval Operati Base, Terminal Island, San Pedro, Calif.